128K Upgrade p.16

July 1983 $2.95

Color Computer MAGAZINE

For TRS-80 ® Color Computer & TDP-100 ™ Users

The Expanding Color Computer

The long-heralded 128K bubble memory upgrade is finally here. It is expensive, but worth it. It is sophisticated, yet not complicated. Build this month's project and avail yourself of 128K of throughly crash-free storage.

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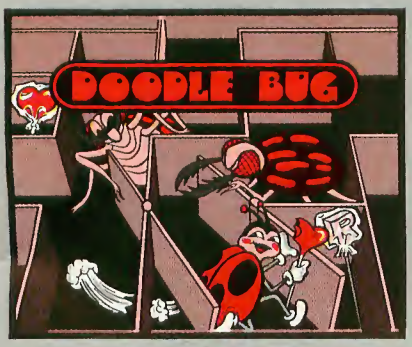
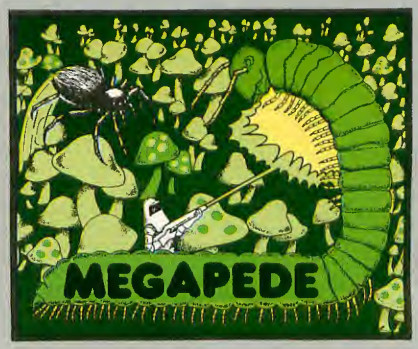


Your Lady Bug hussles thru an intricate maze of barriers & turnstiles, avoiding enemy bugs & skulls.
Cass $24.95 **Disk $29.95**

Turn your keyboard into a musical instrument with a digital synthesizer.
Cass $21.95 **Disk $26.95**



Centipedes & katerpillars are tame compared to the challenge & aggression in this great game!
Cass $21.95 **Disk $26.95**

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Cass $21.95 **Disk $26.95**

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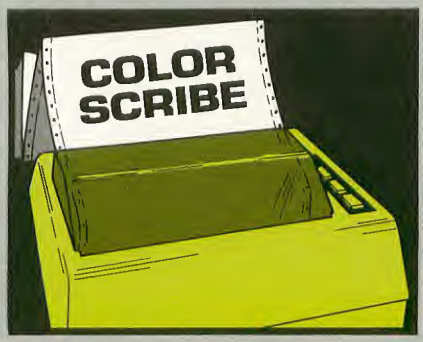

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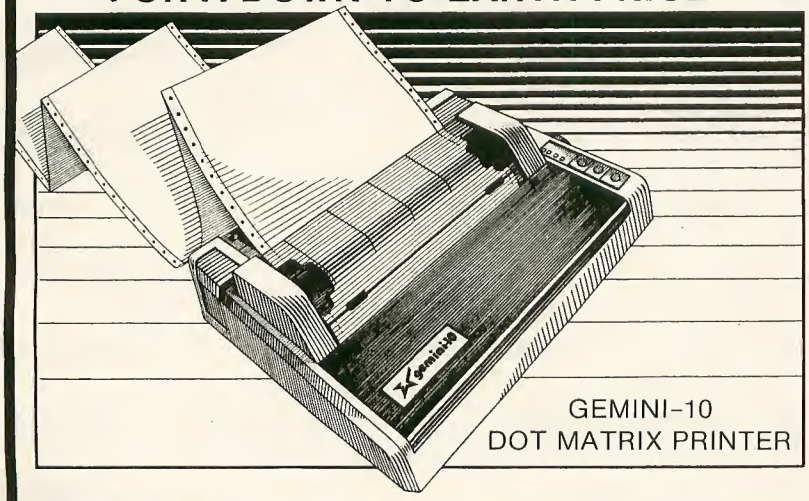

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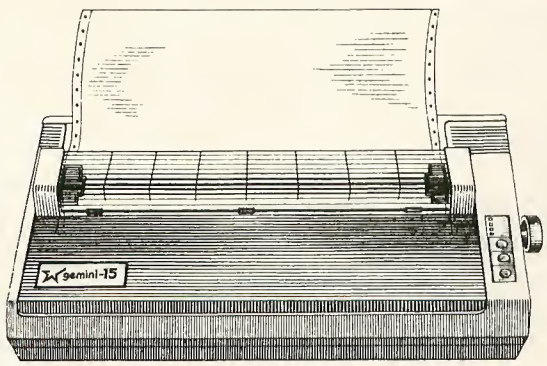

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ISSN 0736-9492

THE Color Computer... MAGAZINE

Vol. 1, No. 5
July 1983

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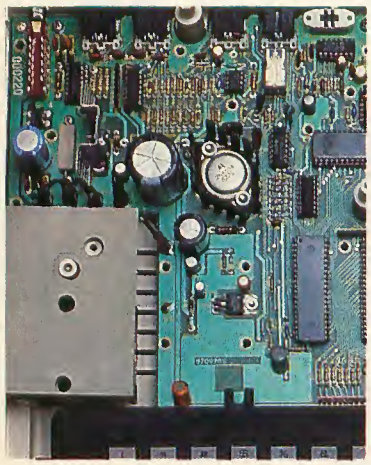

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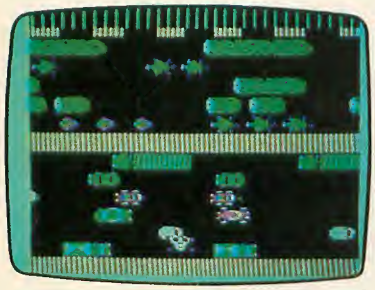

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FEATURES

DEPARTMENTS

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TOM MIX SOFTWARE

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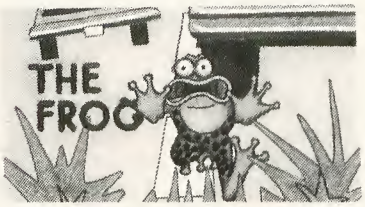
NEW

"THE FROG"

(C) 1983



ARCADE ACTION
This one will give you hours of exciting play... Cross the busy highway to the safety of the median and rest awhile before you set out across thes swollen river teaming with hidden hazards. Outstanding sound and graphics.

16K MACHINE LANGUAGE
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$30.95 DISK

NEW

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1983
32K Ext. Basic

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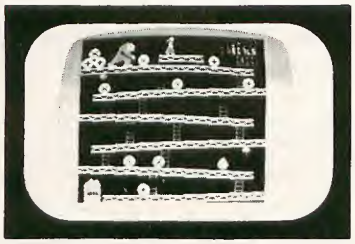
This program gives you the real feeling of flight. Full instrumentation complete to the max. Actual simulation of space flight. **32K Ext. Basic**



THE KING

1982
32K Machine Language
$26.95 tape
$29.95 disk

ARCADE ACTION - How high can you climb? Four full graphic screens. Exciting Sound - Realistic graphics. Never before has the color computer seen a game like this. Early reviews say: Just like the arcade - Simply outstanding!

NEW

"TRAPFALL"

By KEN KALISH
(C) 1983

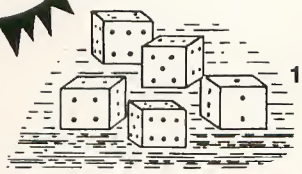
ARCADE ACTION
The "Pitfalls" in this game are many. Hidden treasures, jump over the pits, swing on the vine, watch out for alligators, beware of the scorpion. Another game for the Color Computer with the same high resolution graphics as "The King."

16K MACHINE LANGUAGE
TAPE $27.95
DISK $30.95

NEW

"YAAZEE"

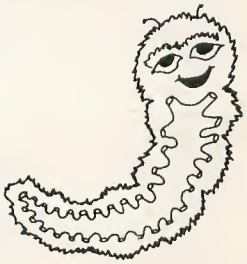
(C) 1983



$19.95
16K MACHINE LANGUAGE
EXT. BASIC

Yaazee is a 2 player game using five dice to get the best poker hand. After game is loaded flashing digit below player number determines which player rolls dice at the start of the game.

KATERPILLAR ATTACK



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DISK **$24.95**

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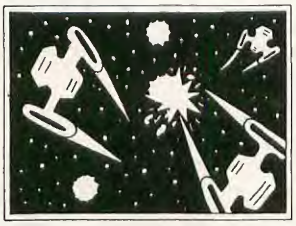

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PEEK (07,83)

By all means, GOTO 16. One of the first people I called when **The Color Computer Magazine** was in its early planning stages was Dennis Kitsz. My timing was perfect; Dennis had just started work on what became this month's Custom Color article — a bubble memory upgrade designed to turn your Color Computer into a 128K powerhouse.

At first I found the concept difficult to swallow. Dennis has a great, and unique, sense of humor. I didn't know if he was pulling my leg or not. When he mentioned that this one megabit upgrade could be upgraded itself to a full megabyte I knew that not only was Dennis pulling my leg, but that he was tugging hard on my chain as well. But there was something in his tone that advised me to humor him because he was obviously setting me up for some other, more believable Kitsz-style wonder.

"You don't understand what I'm talking about, do you?" he asked me. "Sure I do," I said, "You're trying to tell me that I can laugh even louder next time I see an ad shouting the virtues of the IBM PC, or the Apple micro, because this machine sitting in front of me not only has a better CPU but is also capable of storing 128K in its internal memory." "Right," he replied.

Of course I'm making a lot of this up. Time has clouded my memory a bit. But it's true that I didn't believe him when he first mentioned the upgrade to me. It's true we both said some nasty things about Apples and PC's. But if I've learned anything about Dennis Kitsz over the years, it's that no one is better qualified to do the impossible than he.

See for yourself: the impossible begins on page 16. By the time you get to the end of the article you'll know everything you need to know about installing 128K of bubble memory into your Color Computer. Jake Commander is hard at work on an operating system which should be ready in a month or two, or by the time you've built the mod, whichever comes first. For the quick among you, Dennis provides enough software to get you going while awaiting wonders from Jake.

We almost put Custom Color in the back of the magazine simply because we knew it would be a difficult act to follow. Instead we opted to put that burden on Richard Ramella. GOTO 32 for the second appearance of The Sorcerer's Puzzles. Our young apprentices finally get to meet the Sorcerer this time around.

H. Allen Curtis decided that Extended Color Basic needed a new command. GOTO 39 and learn how to create and use the new command DYE when programming graphics.

The cliche that you can't teach an old dog new tricks doesn't apply to programmers. Jake Commander wrote CC Space Trek (**The Color Computer Magazine**, June 1983) on a Disk Basic Color Computer. He sent it to me and I ran it on my disk-based system. The graphic tokenization technique Jake used, as it turned out, didn't work on non-disk systems. Like a true programmer, Jake's reaction to the glitch was, "How about that?" It's a good example of what subtle differences between configurations can occur. Technical Editor Jamie Tietjen worked with Jake on the fix and presents it in "Damage Report, Mr. Scott" (GOTO 46). And while we're on the subject of damage reports, Jamie went through our first four issues with a fine-tooth logic probe. The results are the subject of this month's End of File (GOTO 96).

Last month Shawn Jipp told you how to go about forming a Color Computer Users Group. This month, freelance writers Tim and Debra Cole visited one and share their observations with us. GOTO 48 for "Family Outing — Computer Style." It should be noted that if you are a member of a users group, or contemplate starting one, it is your obligation to respect the rights of people who invest their time and money to give you something to do with your computer. Software piracy is not a small matter. Rather than discuss the subject here, in a single paragraph, next month we'll get deeper into the subject in End of File.

GOTO 52 for "GOTO Where?," a utility to help you find all the GOTO references in any Basic program. Then GOTO 55 for "Dissecting Your ROM" by Jake Commander. This article begins a 12-month series exploring your computer's ROM. The whole project began in April when we published Jake's Color Computer Memory Map. In June, Jake shared his disassembler with us. Now that you have all the nitty gritty, Jake will take you deep into the workings of your machine by explaining what all the addresses in your computer's ROM can do for you. Each month Jake will dissect just over 1K, so that after 12 months you'll have a complete reference guide to the entire 16K Color Computer ROM. Neat stuff.

Many people have written us asking about Color Disk Basic: "What's in it?" "How does it work?" and so on. Franklyn Miller attempts to answer your questions in "What is Color Disk Basic?" (GOTO 64).

In past issues William Barden Jr. showed you some nifty ways to create graphics with your Color Computer. This month Bill complements pictures with sounds. GOTO 68 for "Zounds! Sounds!"

REVIEW$ begin with a comparison of versions of Color Computer Forth written by Forth aficionado Gregg Williams. GOTO 79 for Forth and other reviews.

And don't forget to enter **The Color Computer Magazine** Summer Programming Project for your share of over $6000 worth of Color Computer prizes. GOTO 24 for details

— K.L. Editor

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16K..... **$9.95**

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Triple-Mode Versatility—DMP-200

The DMP-200 is compact, but doesn't compromise on features. You get word processing compatibility with mono and proportionally-spaced correspondence-quality characters, boldface, underline, super and subscripts; a bit-image mode—with repeat and column addressing codes—for superb graphics at no extra cost; and a data processing mode that allows a faster print speed for efficient throughput. At 120 characters per second, the DMP-200 can print an 80-column line at 55 lines per minute. You can use single sheets or standard fanfold paper with the adjustable, removable tractor.

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Sale! CGP-115 Graphics Printer

Now you can get the unique CGP-115 at $50 off! It's perfect for creating anything from color pie charts to computer-generated "doodles". You can print beautiful graphics in four colors—red, blue, green and black—plus you can print alphanumerics. The text mode lets you print 40 or 80 characters per line at 12 characters per second on 4 1/2" wide roll paper. Ideal for program listings! And you can print from one to 80 characters per line in the graphics mode in any size. This ultra-compact printer measures only 2 15/16 x 8 1/4 x 8 1/2" and weighs just 1 3/4 pounds! Uses easily replaceable ink cartridges.

132-Column DMP-400 Business Printer

Like the DMP-200 described at left, our DMP-400 gives you triple-mode versatility for word processing, data processing and dot-addressable graphics. But you also get full 132-column printing at 10 characters per inch. You can print at a speedy 140 characters per second (51 lines per minute). Adjustable, removable tractor allows use of 4" to 15" fanfold paper or use single sheets with the friction platen. The DMP-400 features paper and form feed controls, and its cover design aids in noise reduction.

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INKEY$

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16K Field of Honor

Applause, applause for **The Color Computer Magazine**. Unlike any other Color Computer magazines, you have received large circulation and have gotten onto newsstands and magazine racks across the country. Perhaps now the potential of the Color Computer can be explored and realized by the unknowing majority of the computing public.

We have experimented with a few of the programs and have found a way to fit the Field of Honor program into a 16K machine without losing the musical presentation.

Delete lines 60–200 from the original version and type the following lines in:

```
  5 REM BY SCOTT NORMAN
 10 CLS:CLEAR250:DIM
    MM(6,5):PRINT@137,
    "FIELD OF HONOR";
 35 PLAY "XA$;"
 45 PLAY "XB$;"
 55 PLAY "XC$;"
 65 PLAY "XD$;"
210 FOR T=1TO1500:NEXT
1055 IFC<1ORC>5THEN
    1050
```

Fred Wohlstein & Friend
Greenfield, IN

Disk Registers

In reference to Custom Color, May 1983, Dennis Kitsz forgot to mention one other address in the Radio Shack disk controller. In addition to the four disk-controller registers, $FF48, –9, –A, and –B, there is a 'write-only' eight-bit latch on the controller board that is addressed at $FF40. You cannot read the contents on the latches, but be assured that if you tried to write to that address you would get some surprises from your disks. There is also the 'phantom' address of $FF50 as Dennis explains in his article.

I have nothing but the highest praise for your excellent publication. Keep up the good work.

Ronald J. Uncapher
Ortonville, MI

Programs and Eyesight

I hope with this letter to register vehement complaint about the presentation of program listings in The Color Computer Magazine. Too many of them are printed too small for easy reading.

Robert P. Lockhart
Martinez, CA

Deciding on what size to reproduce program listings was not easy.

At first we used other computer magazines as our guide and reduced the listings accordingly. Either the other magazines have readers with better eyesight than ours, or they're ignoring a lot of mail.

After trying various formats we've settled on what you see in this issue. All Basic listings are printed in a 32-character width, and reduced to fit in no less than half a page. Background tints have been reduced to enhance readability. Machine language listings posed a different problem. They can go on forever. To reduce them to a reasonable size, without causing eyestrain, we've opted to turn them sideways taking advantage of the page's greater width. See Jake Commander's article on page 55.

We hope this helps. — Eds.

Education Notice

Cognitec is willing to donate copies of its early Telewriter version to schools or charitable institutions. If you are interested send a letter to Mr. Howard Cohen at Cognitec. Supplies are limited, and you may have to pay postage and handling.

Paul Kimmelman
Norton, OH

*Dr. Kimmelman will be joining **The Color Computer Magazine**'s staff next month as Education editor — Eds.*

The May review section inadvertantly listed The Stripper as available only from Spectrum Projects. Produced by Eigen Systems, it is available through Spectrum Projects and other vendors. — Eds.

Doing Their Highland Thing

One reason why this magazine's
So colorful (!) with news,
Is due to where it's published.
Do its offices sport views
Of thriving, bustling city life?
Not quite! One sees, instead,
A peaceful country town. (Is that
A billy goat ahead?)

For, high atop America
(Yep, way up there in Maine),
There thrives a tiny berg, whose name
Was Camden-on-the-Plain.
T'was shortened just to Camden,
Since the great Atlantic Ocean
Is right upon the doorstep of
This rugged Land o' Goshen!

A quite unlikely home for our
Computer magazine?
Well, not to hear its staff and crew!
They find their hamlet keen!
Who'd argue? For a very seasoned
Viewpoint is provided
By leathery old 'Sea Salts' who've
In Camden long resided!

A stronger 'business' reason why
The magazine is there?
The weather? No that can't be it!
'Tis blustery, all year!
Is this 'remote' location some
Advanced computer center?
I doubt it! All the area schools
Are ones just fish can enter!

So why did 'Color Computer' locate there?
The Camden type of place
Is one where you can work, and play,
At — more or less — your pace.
The traffic will not hassle you.
(There really isn't much!)
You seem to have more time to think,
And contemplate, and such...

Thus there, in Camden's Highland Mill,
Computing, writing, printing,
The staff resides. From what I've read,
They've clearly not been stinting!
The editorial quality
Is excellent and more!
It pays to be a stone's throw from
A real live general store!

Michael H. Shadick
Minneapolis, MN

Ayuh, thanks Mike. — Eds.

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CLOCK

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26727 16K Extended Basic Tape $24.95

MONEY

From B5 Software

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36548 16K Extended Basic Tape $19.95

SPELLING

From B5 Software

Flexible program allows you to input and store words or use graded data tapes. Words flash on screen from .1 to 10 seconds, then player types the word. Complete a lesson, then watch the attractive graphic display of superlative words and sing along!

36605 16K Extended Basic Tape $16.95

Data Tapes—CANNOT BE USED ALONE $8.95 EACH
35334 Dolch Words
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39260 Grade 3
39226 Grade 4
37617 Grade 5
35356 Grade 6
35312 Adult

TOWER OF FEAR

from Programmer's Guild

Awesome text adventure for novice or experienced. The Wizard's Tower, last of the surviving fortresses, is a catacomb to the omnipresent undead spirit of Blackheart Flamethrower. Enter if you dare, but don't expect to emerge alive!

35031 16K Extended Basic Tape $19.95

ZAXXON

from DataSoft

The official Zaxxon, now for home use, combines 3 dimensional effects, unique color graphics and realistic sound effects. Arcade action while you maneuver your ship through a battlefield of enemy missiles, tanks and planes to meet your match in the deadly Zaxxon Robot armed with a lethal homing device.

35963 32K Tape or Disk $39.95

VOYAGER I

from Avalon Hill

You're on board a spaceship infested with killer robots in this graphic science fiction game. You must clear the 4-level 144-location ship of robots and arm it to self-destruct. Can you do it and escape before you, too, are blown up? High-speed graphics are represented in 3-D perspective representing your eye's view; with instant switching to floor plan maps. Extended BASIC required.

29012 16K Tape $19.95

GHOST GOBBLER

from Spectral Associates

In this new and exciting version of the popular arcade game, use your joysticks to move your Ghost Gobbler through the maze, eating dots and power pills to score points. 8 bonus shapes, super sound, and 16 skill levels. Extended BASIC required; joysticks.

22611 16K Tape $21.95

SCEPTER OF KZIRGLA

from Rainbow Connection Software

Real-time graphics adventure game with arcade sound for the color computer. 13 floors of dungeon with monsters, treasure chests, hidden trap doors . . . even a flying magic carpet! All in your quest to find the Scepter of Kzirgla. Whatever you do, don't get caught in the poisonous gas cloud! Extended BASIC required.

26514 16K Tape $19.95
26525 16K Disk $21.95
Also, Conquest of Kzirgla
27199 16K Tape $21.95
36537 32K Disk $26.95

Programmer's Corner

COLOR COMPUTER DISASSEMBLER

by Jake Commander from Interpro

Learn machine and assembly language while disassembling any portion of your Color Computer's memory. Features easy-to-read 6809 mnemonics and a BASIC program for you to learn how memory is organized and disassembled.

26390 16K Extended Basic Tape $19.95

SUPER "COLOR" DISK-ZAP

by Tim Nelson from Nelson Software

Now, the dream of repair of I/O errors is a reality! Lets you retrieve bashed files including BASIC and Machine Code programs. Special dual cursor screen display shows Hexidecimal and ASC II. Full prompting to help you every step of the way plus manual that teaches disk structure and repair.

23421 Disk $69.95

A BYTE OF BASIC

by Steve Blyn from Computer Island

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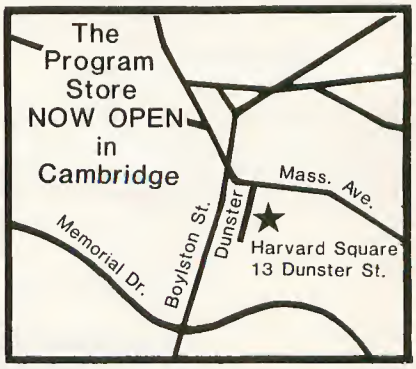
41117 Softcover Book $4.95



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by Brian H. Alsop

NOW THAT YOU HAVE a computer, monitor, disk drive, cassette recorder and piles of tapes, how can they be stored?

My solution is a cart that can be wheeled about. You can roll all of the above components from place to place by disconnecting a power cord and printer cable. Photo 1 shows the finished product. The cost should be less than $75.

Building It

Figure 1 shows four views of the cart and component placement; Figure 2 shows approximate dimensions for the various pieces. Cut them slightly oversize and hand fit as necessary. These dimensions are for my components, so tailor them to your own needs. The dimensions aren't critical, but make sure the monitor rests at eye level when you're seated and the keyboard should be at a comfortable height. Make sure the shelves don't interfere with your knees or ankles.

The top shelf is not as deep as the second shelf, to permit easy access to the keyboard. Similarly, the third shelf is only a portion of the depth to permit installation of electrical outlets under shelf two. I used half-inch plywood for all shelves and sides and two-by-two's for structural pieces. Use glue, screws, nails, and a few angle brackets to assemble the pieces.

I determined the cutout position for the disk drive ROMpak after assembly. A good set of casters allows the cart to roll over deep pile rugs. Cover the plywood edges with quarter-round and screen door trim. I made the disk drive box separately and installed it with screws. The box sides are plywood. For the top and bottom pieces use 3/4 inch shelf board. Glue three small trim pieces to the top of the shelf to prevent the cassette recorder from walking.

How you finish the cart is up to you; remember to seal it with varnish to keep sawdust out of your computer.

Continued on page 14

Figure 1. Component Placement

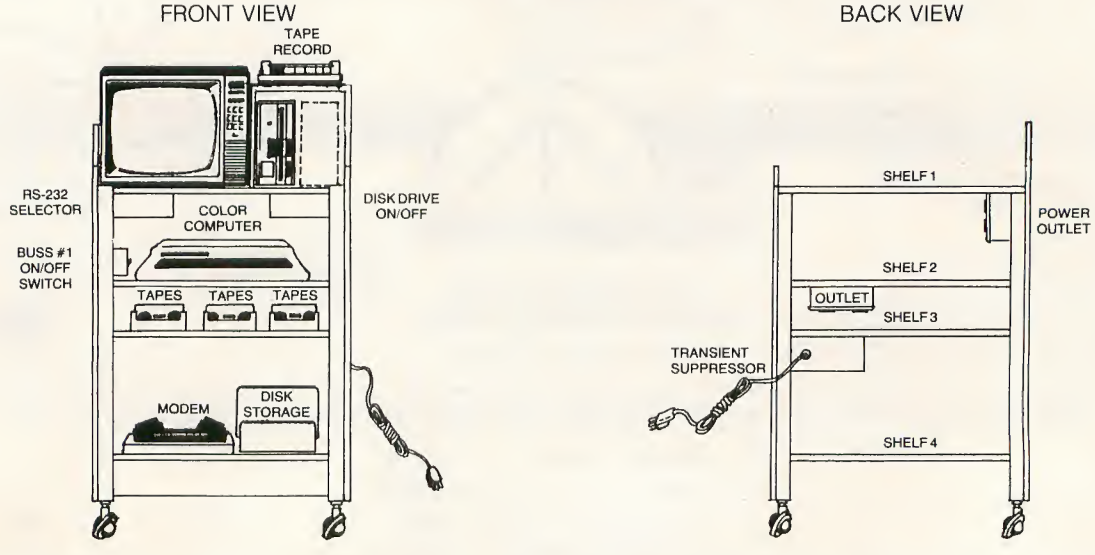

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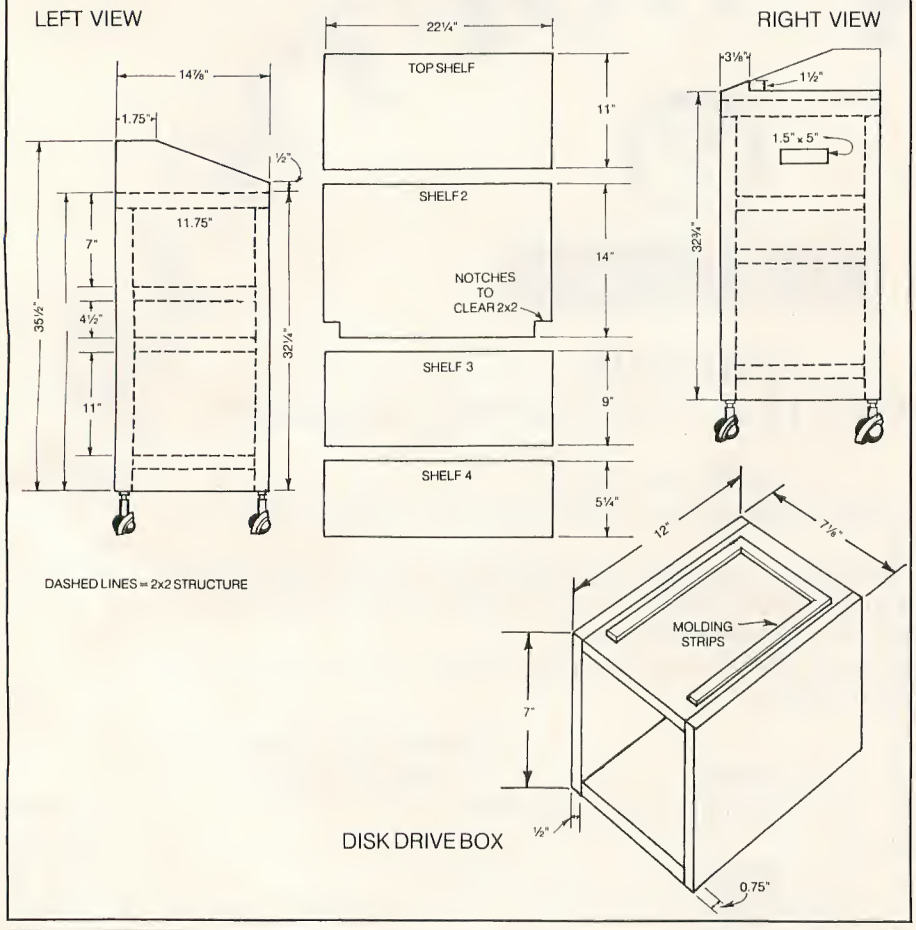
Figure 2. Dimensions



Wiring It

Figure 3 shows the electrical wiring diagram; the power comes from a single grounded cable. A single varistor provides transient protection. This surge stopper appears in Reference 1. Power is then distributed to two switchable buses. Bus 1 services the computer, modem, monitor, and cassette recorder; bus 2 is for the disk drive. I made the disk drive separate from the rest to remind me to remove the disk from the drive before shutdown.

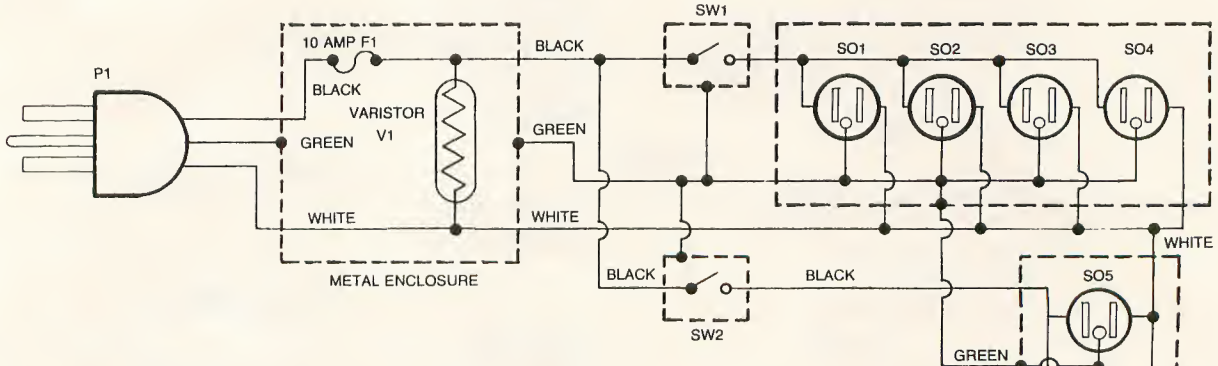
Interconnections between components use standard cables. The RS-232 outlet is fed to a homebrew switch box to select the printer or the modem. The printer, an old model 33 TTY, is not shown and is connected via a long detachable cable. One of my future projects is to make this link wireless by using a pair of discarded CB walkie-talkies.

Placement of the cassette recorder is important. TV's generate interference that can get into your cassette recorder and cause I/O errors. To test for this problem, remove the earphone jack and turn up the volume. If your TV is radiating into the recorder you will hear a buzz. Locate the recorder to minimize this pickup.

With this cart it's easy to move my computer to wherever I want. ■■■

Reference 1. H.Friedman, "Surge Stopper", Radio Electronics Special Projects #4, Summer 1982.

Figure 3. Wiring Diagram



P1 = 3 WIRE GROUNDED PLUG + 20' 16 AWG FLEXIBLE CHORD
V1 = GE-MOV (V130PA20C)
F_1 = 3AG 10 AMP SLOW BLOW FUSE
SW1 = SPST MASTER SWTICH FOR COMPUTER, MODEM, ETC.
SO1-SO4 = 3 WIRE RECEPTICLES FOR COMPUTER, MODEM, ETC.
SW2 = SPST SWITCH FOR DISK DRIVE
SO5-SO6 = 3 WIRE RECEPTICLES FOR DISK DRIVE

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Circle No. 7 on Reader Service Card

Custom Color

Try 128K bubble memory on for size.

by Dennis Kitsz

I'LL TELL YOU right from the start: This project is expensive. But, yes, this project *is* worth it. Surprisingly, it isn't complicated, but it's more sophisticated than any other peripheral for your Color Computer. What is it? The long-heralded, and finally accessible, bubble memory.

This month's article contains a lot of technical information, and if you are one of those folks who thought integrated circuits were at last beginning to make sense, get ready for an entirely new world of technology. Although bubble memory can be made to act like an ordinary computer device, it bears little electronic resemblance to familiar circuitry. It uses mysterious concepts such as "magnetic domains," and refers to coils and chevrons and synthetic garnet.

Nevertheless, you can build this month's bubble memory project and avail yourself of 128K bytes of thoroughly crash-free storage. Before you heat up those soldering irons, though, let's talk theory.

Mysteries of the Bubble

We've all played with magnets, and you can probably remember those days in science class when you slipped a piece of paper over a horseshoe magnet and dumped iron filings on the paper. Some stood up; others huddled together, forming elegant magnetic patterns on the paper. These are the familiar north-south representations of magnetic force. Yet at the minute, molecular, crystalline level, magnetism behaves curiously. A thin wafer of matter has its magnetic polarities flattened out; random, poorly differentiated areas of magnetism are found floating through the wafer. If an external magnetic field is created above and below the thin material, the magnetic areas attempt to come to attention, forming somewhat more regular (but smaller), pools. You might consider it akin to patterns of vegetable oil on the surface of a pot of water. As the oil breaks into smaller puddles, the puddles increase in regularity. If the puddles of oil are broken up vigorously, they become tiny, even circles. Likewise, when the magnetic forces above and below the thin wafer of matter (garnet crystal, in this case), are made strong enough, the magnetic areas form tiny, regular bubbles. These regular bubbles can be tamed, and, by alternating the character

Continued on page 19

Technical Background

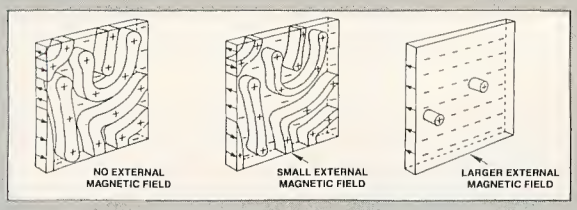

Figure A. *Magnetic bubbles are formed in a thin film of certain crystalline materials as the external magnetic field is increased.*

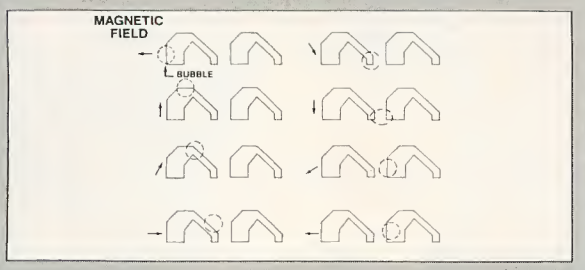

Figure B. *Bubbles are propagated around asymetrical chevrons by a rotating magnetic field; the bubbles move with the field from an area of lesser magnetism to an area of greater magnetism.*

The magnetic bubble memory is a unique solid-state storage technique, combining a century-old technology of electromagnetic wire coils (for bubble motion), analog sensing (for reading the bubbles), familiar but recent digital electronics (for interfacing), and a thin film of magnetic material (where the bubbles themselves exist).

Intel's "Primer on Magnetic Bubble Memory" (available at no charge from the Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051), describes magnetic bubble memory this way:

"A magnetic bubble memory stores data in the form of cylindrical magnetic domains in a thin film of magnetic material. The presence of a domain (a bubble), is interpreted as a binary 1, and the absence of a domain is a 0. Bubbles are created from electrical signals by a bubble generator within the memory, and reconverted to electrical signals by an internal detector.

"Externally the memory is TTL-compatible.

"An external rotating magnetic field propels these cylindrical domain bubbles through the film. Metallic patterns or chevrons deposited on the film steer the domains in the desired directions. Transfer rates, once started, are in the tens of thousands of bits per second, but because the data circulates past a pickup point at which it becomes available to the outside world, there is a latency averaging tens of milliseconds before data transfer can begin.

"In these respects, magnetic bubble memories are serial high-density storage devices like electromechanical disk memories. However, in a disk, the stored bits are stationary on a moving medium, whereas in the magnetic bubble memory the medium is stationary and the bits move."

This is an excellent summary, although it's hard to imagine exactly what the bubbles are and how they move.

Magnetic materials — that is, materials which can be magnetized — contain random patterns of magnetic areas called domains. Domains are present in wrenches and cassettes, screws and loudspeakers. By magnetizing this material, the domains can be forced into patterns pointing in one direction. These large domains don't themselves move, but in a sense reorganize in a common direction. The material is then considered magnetized.

In very thin films of some kinds of crystalline matter (less than one-thousandth of an inch thick), the magnetic domains are all perpendicular to the wider expanse of the film (Figure A). That is, their poles are oriented toward either the top or bottom surfaces of the crystal wafer. At this point (before being magnetized), since because of the thinness of the wafer they seem to have no third dimension, their linear shape can be described as snakelike. By creating a permanent magnet sandwich above and below the wafer, four stages of magnetization can be made to occur. Under a weak magnetic field, all the perpendicular magnetic domains will orient their polarity in one direction — all the snakes will "belly up." As the external field is increased, the domains will shrink in width and length. An even stronger field will cause the domains to contract into cylinder shapes (which look like bubbles from above). At the extreme, the bubbles will disappear completely as the entire crystal wafer becomes evenly magnetized at its surface.

It is the third, cylindrical state which is important. This bubble domain can be made to move from an area of less magnetism to an area of greater magnetism. Intel's technique for bubble motion involves depositing asymetrical, V-shaped magnetic patterns (chevrons) on the surface of the thin film (Figure B). By means of rotating the magnetic field (by changing the current pulses in a pair of perpendicular electromagnetic coils surrounding the wafer), the bubble is forced to follow the magnetism induced in the chevron. The bubble is led around the chevron from its thick side to its thin side. As the magnetic field continues to rotate, the bubble finds itself at the end of the "V" leg with nowhere to go. It begins to stretch out, and the bubble is plucked from the thin chevron leg by the stronger field of the neighboring thick chevron leg. It continues around the new chevron, as the pattern repeats itself. The bubbles move.

Reading the moving bubbles is similar to reading the data from a disk. The bubbles are first replicated (split into duplicates) and placed on an output loop. A magnetoresistive detector — similar to a tape recording head — senses the moving bubbles and sends the information through amplification and shaping circuitry. The sense amplifiers and other external ICs organize the information into data usable by a microprocessor.

Writing data to a bubble involves taking new bubbles created at the input loop, and swapping tracks with an existing loop. The previous loop is then bumped out the end of the input track, where it is lost. The new data continues in the storage loop.

Bubble memory is unique because it is said to be non-volatile; at first it is difficult to understand why. The answer lies in the fact that permanent magnets are an integral part of the bubble memory package, keeping the magnetic domains upright and in place. If power fails, the only change to the existing situation is that the fluctuating electromagnetic field pulses which move the bubbles around simply stop. If data is being read at the time, it is merely a duplicate residing in the output track, not the original. If data is being written, only the swap time — a few microseconds — is critical. Power-fail detection circuitry keeps the swap going until it is complete.

Bubble memory is so stable, in fact, that you can remove the bubble from its socket when you are finished with it and take it with you.

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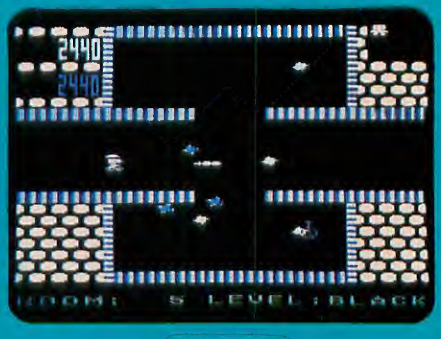

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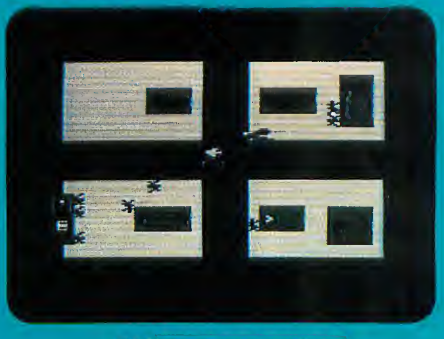

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Continued from page 16

of the magnetism nearby, they can be jostled around the crystal in a predictable manner. In fact, with just the right amount of bumping, the bubbles can be made to resemble nothing less than binary information!

Not convinced? Well, I guess I'm skeptical too, but bubble memories are just too expensive to chop up to see what's inside. My sales brochure from Intel Corporation has lots of pretty pictures of bubble memories being created by white-clothed lab techs, so for now I'll just accept that as true.

The technological trick to bubble memory is getting the magnetic domains to behave. There are over one million of them to keep track of, and unlike disks or other conventional (read that as "reasonable"), devices, it's the *bubbles* that move while the rest of the device stays still!

I'm hard put to come up with an analogy for exactly what goes on inside the bubble devices. You can imagine the process as a kind of micro-magnetic slam dancing. You crash into someone just as they turn to the beat, flinging you into someone else. You're the bubble, the someone else is a chevron-shaped pattern of magnetizable material deposited on the surface of the garnet, and the beat is a constantly alternating magnetic field surrounding the whole business. A field of just the right strength can slide a magnetic bubble from one chevron to the next.

What then? Why, the passing bubbles are duplicated into short "loops" to be read by an output track, amplified and shaped into proper digital signals. It's very similar to reading information on a disk, or playing back any kind of magnetic recording. A sense and read amplifier provides this good digital signal to the bubble controller chip — a sophisticated integrated circuit in the same class as disk controllers. The bubble controller assembles the information into bytes, which are provided upon request to the computer.

The data writing process is similar. Information is assembled by the bubble controller, provided to the coil driver amplifiers and power transistors, and embedded in the bubble's reserved input loop or track. At the proper time, the input loop is duplicated (by swapping the magnetic domains), into the selected loop in the main storage area.

All this provides a memory device which is environmentally stable, unaffected by power loss (since the permanent magnets in the bubble are responsible for maintaining the memory), compact (the 128K bubble is 1 1/2 inches square), and significantly faster than disk or tape storage.

The Color Interface

The circuit described this month allows the TRS-80 Color Computer to be interfaced to an Intel BPK-72 bubble memory prototype kit. Details on purchasing this kit (about $300), or a complete Color Bubble system, are provided at the end of the article.

Interfacing the BPK-72 to the TRS-80 Color Computer turns out to be a fairly simple hardware task. The bubble controller — the main communication device between computer and bubble — requires just two addresses from the computer's memory map, plus the usual reset, read/write and data signals, all available at the Color Computer's cartridge connector. A power supply (5 and 12 volts) is also needed, together with a 4 MHz clock used for bumping along the magnetic domains within the bubble memory system. The rest of the system's operation is handled in the software.

Before beginning this project, please take note of several things:

- The Color Bubble system costs more than the entire computer, and each 128K bubble is an additional $100 investment. That means it is not an economical replacement for disk storage, but can act most effectively as a kind of extended RAM or fast-access storage compartment for a dozen of your best programs.
- The Color Bubble needs an operating system before it can function. A bubble operating system can be extremely rudimentary or as sophisticated as the best disk operating systems on the market. Jake Commander is working on one that you'll find in **The Color Computer Magazine** in the next month or so, and is putting finishing touches on The BOSS (Bubble Operating System Software), a high-powered interactive system.
- The Color Bubble is only one part of a coherent system of Color Computer peripherals which are being presented regularly in this column. Hence, the address decoding is taken from the group of phantomed addresses found in the disk area. Refer to Custom Color, April and May 1983 columns for details. In this case the addresses are selected by demultiplexer circuit U5, and provided, through suitable decoding, to the type 7220 bubble controller chip on board the Intel BPK-72 bubble memory kit.

An operating system — or at least a bubble "boot" — must be provided so the unique machine language commands of the bubble controller chip can be embedded in the Color Computer's Basic language. It can be typed in, loaded from tape, or (best of all), be present in a ROM of some kind. The bulk of the operating system can be contained in the bubble itself, but something must boot that operating system in place when the computer is turned on. Figure 1 is the complete schematic for the bubble interface and for an operating system EPROM (a standard 2716 or 2732 erasable memory).

For those interested in a single-board, hard-wired system — including the I/O port from April and May, and the upcoming EPROM programmer, real-time clock, and other circuits — the select signals (marked W, X, Y, and Z) are ORed for feeding through. Optionally, the 74LS139 may be left out of subsequent boards, and the select signals taken from the first board plugged in place (normally the I/O board), or from a motherboard of some kind. Plans for a completely buffered motherboard will be provided in a later column. In the meantime, you can socket the 74LS139 for later removal if you build the motherboard system.

The Intel Bubble System

The history of bubble memory is filled with starts and stops, of announcements and failures, and of companies investing huge sums of money only to sooner or later drop out of the technological race. Despite several years of research, then, bubble memory is still in its infancy. This in turn leaves a standardization gap to be filled; that, alas, is in the future.

With several competing systems now available — none compatible with any other — I found it necessary to choose only one to work with; I selected National Semiconductor. After two months of work, I opened Electronic Engineering Times to discover that National had dropped its bubble memory division; the telephone number I had used the day before was disconnected. Remaining were Fujitsu and Intel, and a wave of patriotism came over me. I selected the Intel product, which turned out to be stable and reliable, though more expensive than Fujitsu's bubble.

The Intel bubble memory product comes in several forms, including individual components and complete boards and systems. The interface presented in this article connects the Color Computer to the Intel BPK-72 prototype kit. This kit, available from Intel distributors, consists of: a type 7110 one-megabit magnetic bubble memory; a 7250 coil predriver; two 7254 quad VMOS drive transistor arrays (for alternating the pulses in the bubble memory coils); a 7230 current pulse generator; a 7242 formatter/sense amplifier (for reading the boot loop); a

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Continued from page 19

7220 magnetic bubble memory controller (to interface with the computer); power-fail detection circuitry; a circuit board; and all parts and documentation. Also included are a dummy module, necessary for testing the proper operation of the circuit board before inserting the costly bubble memory itself; and a seed module, needed for re-seeding the bubble if the boot loop information is accidentally erased.

The BPK-72 is fairly straightforward to build, although it is no Heathkit project. Intended as an evaluation board for engineers, the BPK-72 contains a schematic diagram and parts layout, but no step-by-step instructions or construction hints. The process is complicated slightly by a series of changes made to the BPK-72 printed circuit board which were not reflected in the documentation provided with it. Although Intel has promised to update the documentation, as of this writing it remains unchanged. When constructing the BPK-72, then, be aware of the following changes to the Revision H circuit board (Figure 2):

1. C18 has been changed from a ceramic to an electrolytic capacitor of the same value. Be careful to note the correct orientation of this capacitor.
2. R8 has been changed from 12K to 1K.
3. The melt-on socket has been replaced by a screw-down socket.
4. The unidentified parts on the circuit board are:

U8	75463 integrated circuit
R17	3.9K, 1/4 w
R18	5.6K, 1/4 w
R19	5.1K, 1/4 w
C20	.01 mF, ceramic
C21	.01 mF, ceramic
CR1	1N914 diode
CR2	1N914 diode

To construct the BPK-72, install the sockets, then the small parts, and finally insert all the integrated circuits, except the 7110 bubble. When construction is complete, set the BPK-72 aside and begin work on the interface.

Bubble Interface Construction

You can choose any method for wiring the interface (point-to-point or wire-wrap), which is not a complicated task (Figure 1). I recommend using the Radio Shack prototyping boards (276-163 $4.95 or 276-165 $9.95), which are more than convenient, since they are made to plug directly into the comput-

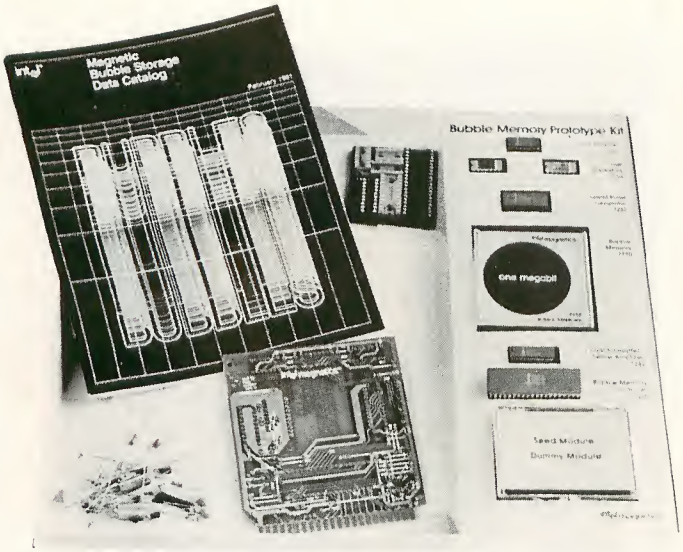


Photo 1. *The Intel BPK-72 bubble memory prototype kit contains the complete data, all integrated circuits and test modules, small parts and sockets, and a high-quality printed circuit board.*

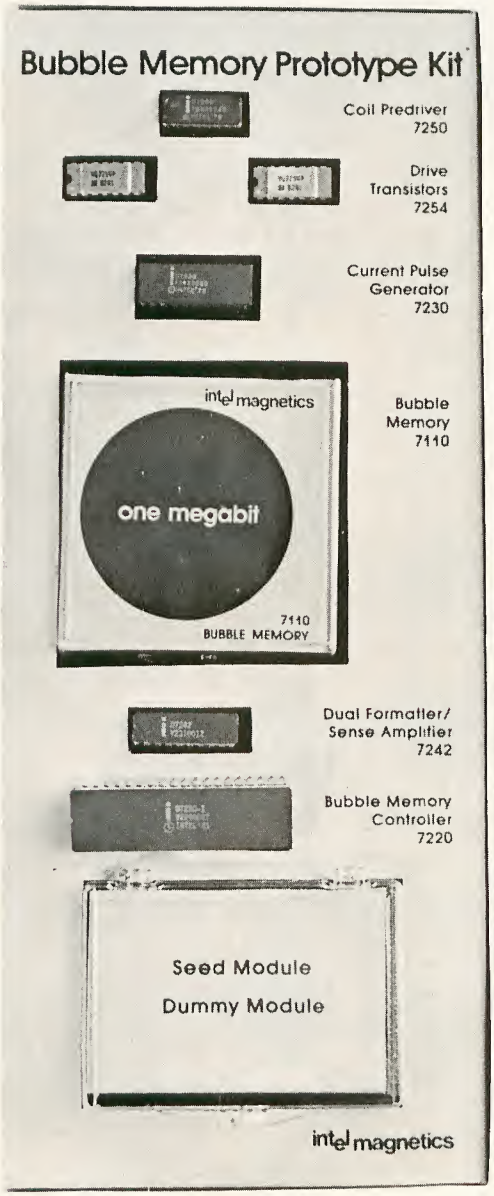
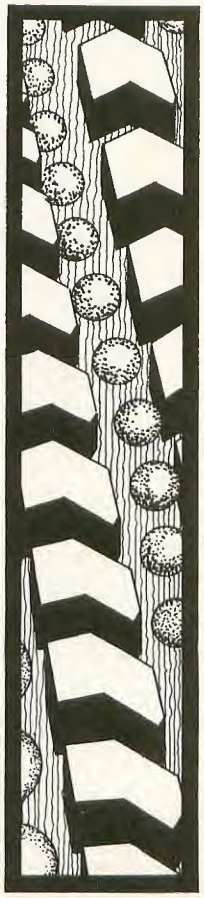


Photo 2. *Complete integrated circuit set provided with the BPK-72 includes the bubble memory, five peripheral chips, bubble memory controllers, and test modules.*



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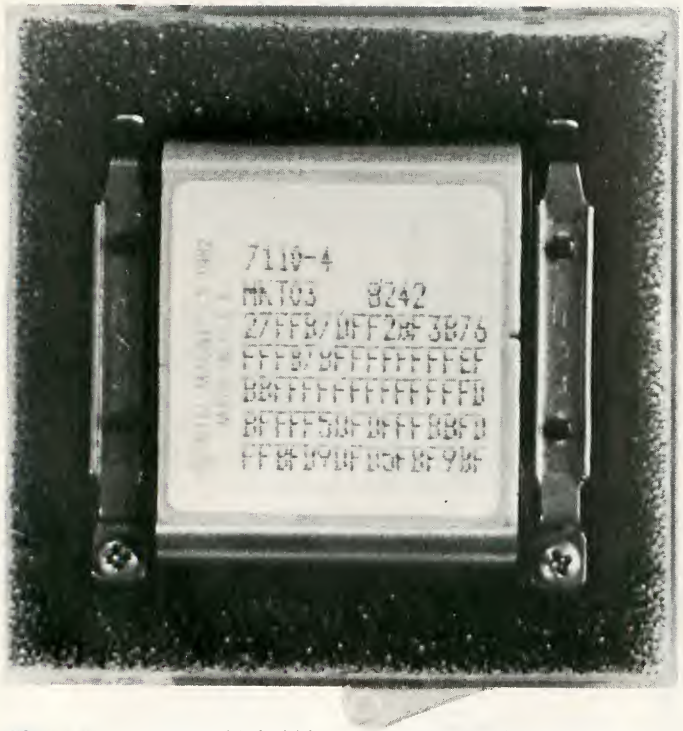


Photo 3. *A one-megabit bubble memory, provided with its socket. The information printed on top is a map of the good loops inside the bubble. At this early stage of bubble technology, 25 percent additional bubble loops are provided for redundancy, guaranteeing 100 percent quality of the final memory. Should seed information be erased by the user, the map allows it to be restored using the seed module, for use by the format/sense amplifer.*

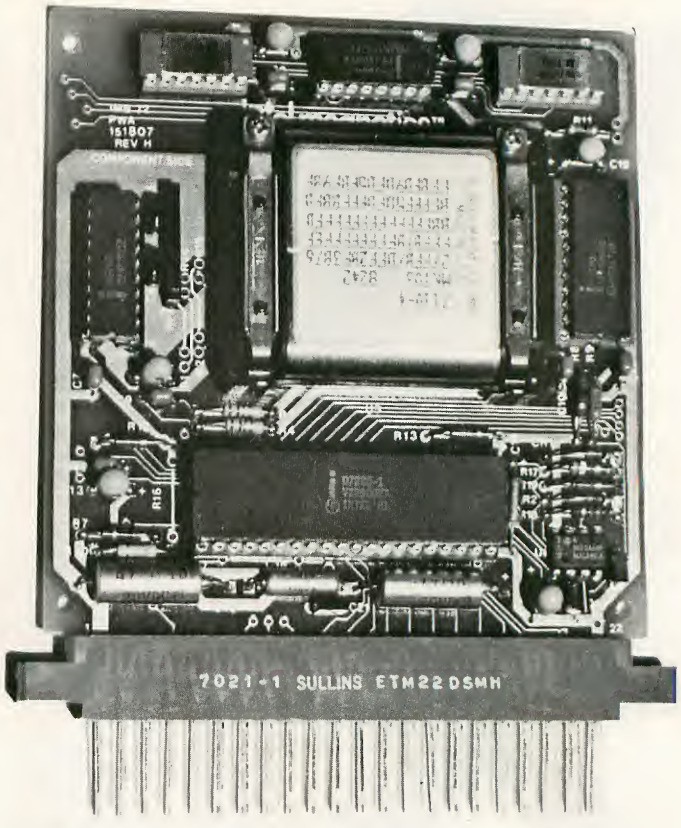
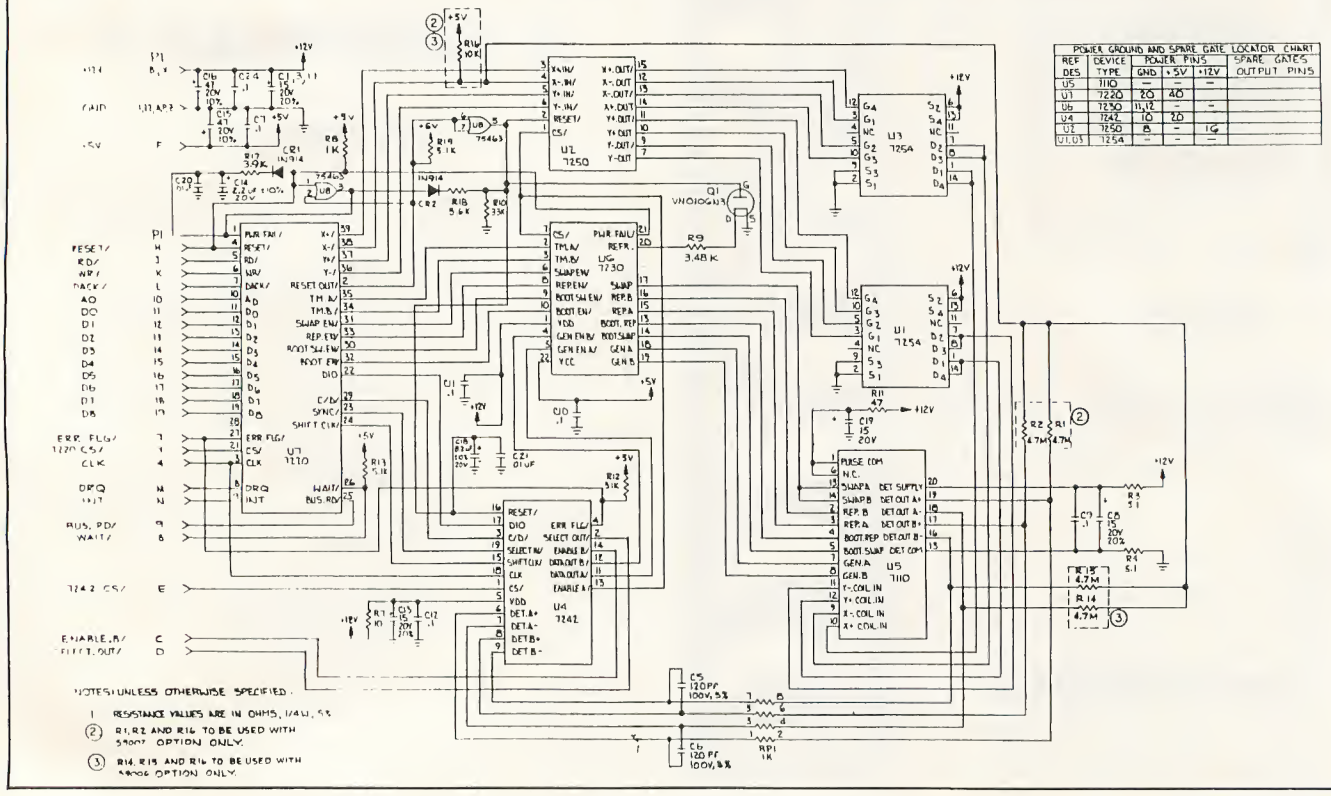


Photo 4. *A complete BPK-72 bubble memory board inserted in a 44-pin edge connector. Write circuitry is at the top, read and sense circuitry at the sides, controller at the bottom, and the bubble itself in the center.*

Figure 2. *Schematic for the BPK-72 bubble memory board made by Intel. This schematic is for the latest revision board.*



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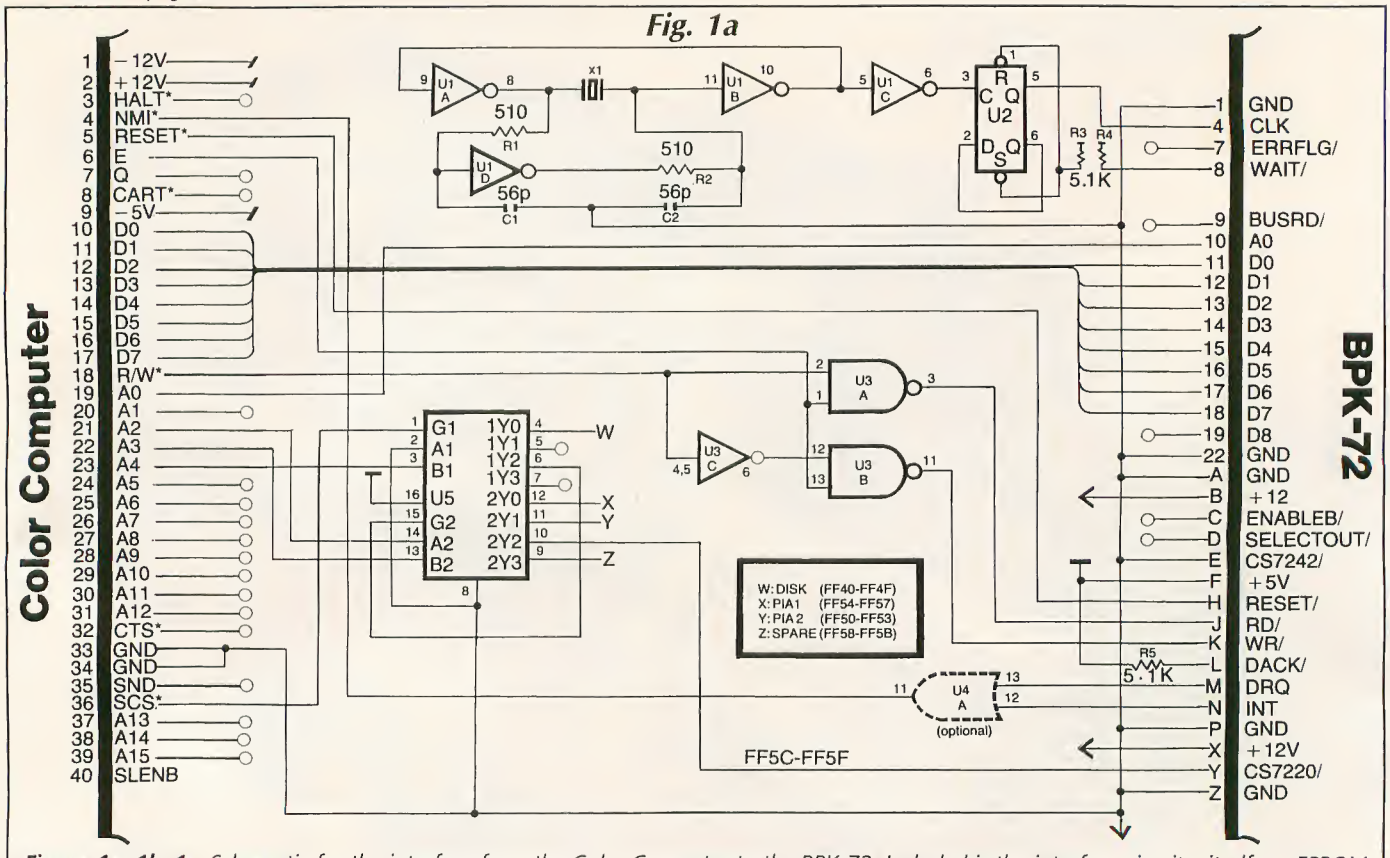

Figure 1a, 1b, 1c. *Schematic for the interface from the Color Computer to the BPK-72. Included is the interface circuitry itself, an EPROM for containing the bootstrap and system programs, and an optional interrupt signal.*

Summer Programming Project

We decided to give you something to do this summer: write an original game for the Color Computer. It can be an adventure, simulation, arcade, or any type of game imaginable. It can be written in Basic or assembly language. It can be long or short, it's all up to you. Just make sure you get it to us by Labor Day, September 5, 1983.

Entries should be submitted on cassette tape or disk with clearly written instructions for use. All entries will be held until October 1, 1983. For the return of entries not selected for prizes, include a self-addressed stamped envelope with you program. All winners will be announced in December's issue of **The Color Computer Magazine**. Entries will be judged by **The Color Computer Magazine**'s editorial staff. All decisions are final.

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\# Machine language winner only
\+ Basic winner only

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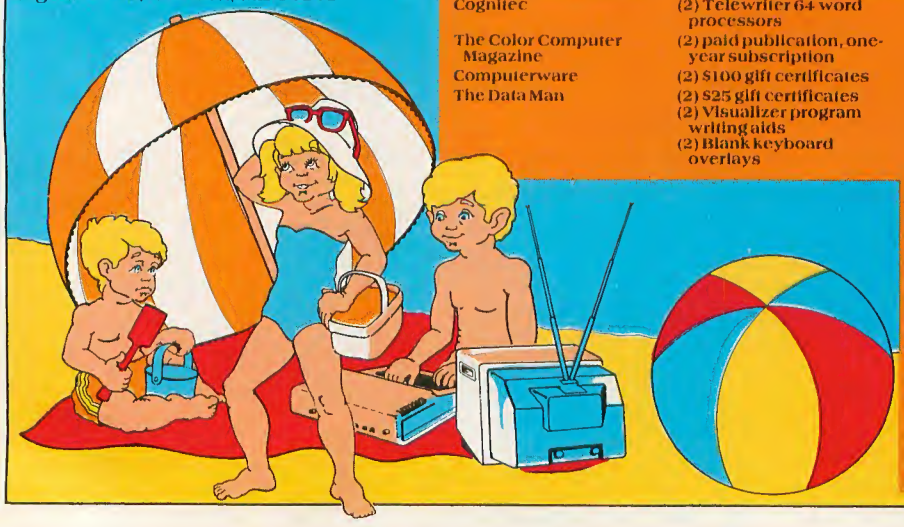


Fig. 1b

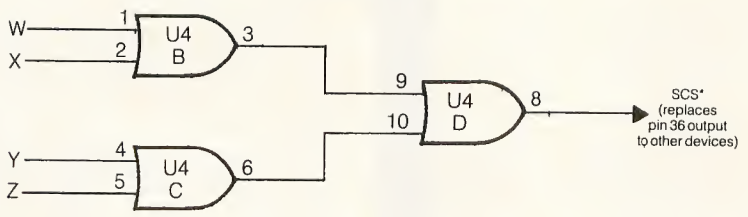
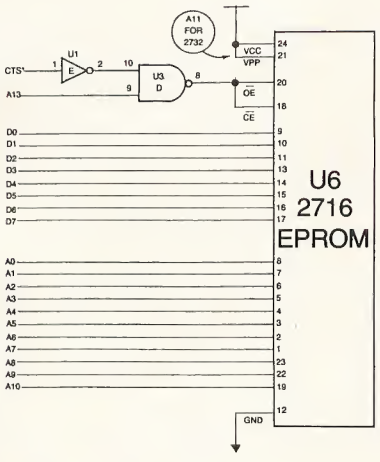


Fig. 1c



A0	D7	D6	D5	D4	D3	D2	D1	D0	Symbol	Name of Register	Read/Write
1	0	0	0	1	C	C	C	C	CMDR	Command Register	Write Only
1	0	0	0	0	B	B	B	B	RAC	Register Address Counter	Write Only
1	S	S	S	S	S	S	S	S	STR	Status Register	Read Only

SSSSSSSS = 8-bit status information returned to the user from the STR
CCCC = 4-bit command code sent to the CMDR by the user
BBBB = 4-bit register address sent to the RAC by the user.

Table 1. *Register addressing of the 7220 bubble memory controller (overview).*

RAC A0	RAC B3	RAC B2	RAC B1	RAC B0	Symbol	Name of Register	Read/Write
0	1	0	1	0	UR	Utility Register	Read or Write
0	1	0	1	1	BLR LSB	Block Length Register LSB	Write Only
0	1	1	0	0	BLR MSB	Block Length Register MSB	Write Only
0	1	1	0	1	ER	Enable Register	Write Only
0	1	1	1	0	AR LSB	Address Register LSB	Read or Write
0	1	1	1	1	AR MSB	Address Register MSB	Read or Write
0	0	0	0	0	FIFO	FIFO Data Buffer	Read or Write

B3B2B1B0 = 4-bit contents of RAC at the time the user makes a read or write request with A0 = 0.
LSB = Least Significant Byte
MSB = Most Significant Byte

Table 2. *Register addressing of the 7220 bubble memory controller (detail).*

D3	D2	D1	Do	Command Name
0	0	0	0	Write Bootloop Register Masked
0	0	0	1	Initialize
0	0	1	0	Read Bubble Data
0	0	1	1	Write Bubble Data
0	1	0	0	Read Seek
0	1	0	1	Read Bootloop Register
0	1	1	0	Write Bootloop Register
0	1	1	1	Write Bootloop
1	0	0	0	Read FSA Status
1	0	0	1	Abort
1	0	1	0	Write Seek
1	0	1	1	Read Bootloop
1	1	0	0	Read Corrected Data
1	1	0	1	Reset FIFO
1	1	1	0	MBM Purge
1	1	1	1	Software Reset

Table 3. *The 16 commands of the 7220 bubble memory controller. For details of the use of the commands, refer to the 7220 data sheet or application notes (packed with the BPK-72 kit).*

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Continued from page 25

er's 40-pin, 0.1-inch spaced, female edge connector. These boards are high-quality fiberglass, and will save you much work. The 2716 EPROM (Radio Shack part number 276-2507, $6.95) is optional if you wish to have the operating system reside in ROM and save space in the bubble itself. Also, an on-board ROM makes initialization easier, since you won't need to type in or load from tape the bubble operating system bootstrap routine.

The most critical part of this construction project is the power supply. Although quite simple, it is important that this be completely built, tested and verified before either the bubble board or the interface is connected. Wire the power supply as shown in the schematic, but do not connect the power leads to the rest of the circuit. Apply power to the supply and measure the voltages. Verify that the 5 and 12 volt supply sections are putting out the correct voltage.

Important note; It is especially important when working with the Color Computer to have someone else check your work. *No matter what you build, have a friend proofread it for you.* In my years of writing about computers, I have found that *damage is almost always caused when readers don't take the time to proofread their work.* Do it. Save yourself the aggravation and me the time it takes to answer your letter.

When the power supply is working, wire the remainder of the interface. If you choose to include the EPROM, wire this section first. If you have an EPROM already programmed with any information at all, put it in the EPROM socket, and insert the interface in the Color Computer cartridge slot. Power up the interface first, then the computer, and PEEK through memory locations starting at $E000 (57344 decimal) to assure yourself the information is there. Remove the interface and complete the construction.

Again test the unit by inserting the interface, powering up the computer, then the interface, and verifying that all computer operations are normal. *If at any time the computer locks up or fails to operate properly, immediately turn it and all peripherals Off!* The central processing unit of the Color Computer is unbuffered and delicate; remember to have someone else check your work.

Testing Your Bubble System

By this time you should have a complete, working interface, and an assem-

Listing 1. *Bubble memory test routine, to be used before insertion of the 7110 bubble memory.*

```
10 CLS : PRINT"Bubble Memory Test Routines" : PRINT
20 PRINT"Use the dummy module, not the 7110!" : PRINT
30 D=&HFF5C : S=&HFF5D : REM * D=DATA S=STATUS
40 POKES,11 : POKED,1 : POKED,16 : POKED,8 : POKED,0 :
   POKED,0 : P=PEEK(S) : PRINTP" = current status" : IF
   P=64 THEN PRINT"This value is correct" ELSE PRINT "This
   value should be 64" : REM * Set up 7220 controller
60 GOSUB 1000
70 ON A GOTO 80,40
80 CLS : PRINT"Beginning next test..."
90 FOR X = 1 TO 40 : POKED,X : NEXT : REM * Fill 7220
   byte buffer
100 P=PEEK(S) : REM * Again check status
110 IF P=41 THEN PRINT"Bubble buffer full; continuing"
    : GOTO120 : ELSE PRINT"Bubble buffer status bad." :
    PRINT"Trying again" : GOTO 90
120 PRINT"Now reading buffer..."
130 FOR X = 1 TO 40 : PRINT PEEK(D); : NEXT : REM * Read
    back bytes from 7220
140 PRINT : PRINT"The above should read 1 to 40"
150 GOSUB 1000
160 IF A=1 THEN 170 ELSE 120
170 PRINT"Initial interface tests complete."
180 GOSUB 1000
190 IF A=1 THEN RUN ELSE END
1000 PRINT"(C)ontinue or (R)epeat Test"
1010 A$=INKEY$ : IF A$="C" OR A$="c" THEN A=1 : RETURN
1020 IF A$="R" OR A$="r" THEN A=2 : RETURN
1030 GOTO 1010
```

bled BPK-72 bubble memory board with all integrated circuits installed except the 7110 bubble memory itself. Put the dummy module in the socket; note that the socket provided is a newer Augat type that opens by loosening two screws. Lift up the socket locking arms, drop in the dummy module (there is a small notch to guide it to the correct orientation), and relock and screw down the arms.

Connect the boards together and apply power (the boards are not yet hooked to the computer). Verify that the voltages are still correct, and that they are present on the BPK-72 board as noted in the schematic. Remove the power, wait a short time for the capacitors to discharge, insert the complete unit into the computer, power up the computer, power up the interface, and refer to Listing 1.

The listing is a short Basic program that runs the interface and bubble controller through their paces. It will verify the proper operation of the bubble system as a whole by reading from and writing through the controller chip, which cannot operate correctly without: proper addressing from the interface; correct clock frequency from the interface; accurate information from the format/sense amplifier; *and* a stable power supply.

If it passes this test, you're ready to continue. If not, stop now and recheck all your work! Here is a quick checklist of places to look:

- Are all solder joints made on both boards?
- Are all wires connected (if you used a wire-wrap or point-to-point technique)?
- Are all solder joints good (shiny)?
- Are the boards inserted straight?
- Is either board inserted backwards?
- Are all ICs inserted in the correct direction?
- Are any pins crushed under ICs?
- Are any pins slipping out the sides of sockets?
- Are ICs in the proper sockets on both boards?
- Does the power supply still test okay?
- Are all resistors installed on the interface?
- Is polarity correct on all BPK-72 electrolytic capacitors?
- Does any part get very hot?

Once you have corrected any problems, your board should pass the test program, since the interface is simple and the bubble board is extremely reliable. The final step is recommended but not absolutely necessary if your soldering and assembly technique is good; the most damage you can cause is to lose the seed information from the bubble, which is printed on the top of the bubble itself and can be restored at any time. To avoid the possibility of this inconvenience it is wise, before inserting the 7110 bubble memory, to verify that all the coil drive signals are occurring at the proper times and voltage levels. Prepare the program in Listing 2 on an Editor/Assembler (EDTASM+ or equivalent), or use the Basic program in Listing 3. Running this program will produce a continuous stream of coil pulses, which can then be displayed on an oscilloscope. Figure 3 presents the waveforms that must be visible on the 7110's socket pins.

The details on the interpretation of these signals are found in Intel's application note AP-119, on page 18. This information is provided with the BPK-72 kit, so if your waveforms don't come close to those shown in the figure, be sure to refer to this note. If everything checks out fine to this point, you're ready to use the bubble memory.

What's It Good For?

When considering this project I asked myself, why would anyone want to spend $350 or more to have bubble memory? Why not just have a disk drive for the same price?

The most important answer for me is experience: What have I done over time with my two Model I disk drives?

Actually, it turns out I only use one of them in true read/write fashion — drive 0 simply contains all the utilities, such as Electric Pencil, Scripsit, Disk Basic, Superzap, and about 15 others on a write-protected disk. I seldom change the disk; drive 1 gets the workout.

In effect, my bubble memory becomes drive 0. It's 128K can contain your utilities, plus any other frequently used information. Since it is so fast, it acts like you have the programs in RAM. From my per-

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Listing 2. *Assembly listing of control signal waveform generation program, used for testing the BPK-72 timing.*

```
                        00100 * A PROGRAM TO CREATE COIL DRIVE
                        00110 * SIGNALS FOR OSCILLOSCOPE DISPLAY
                        00120 *
1000                    00130          ORG     $1000
                        00140 *
1000 86  0B             00150 START    LDA     #$0B
1002 B7  FF5D           00160          STA     $FF5D
1005 86  00             00170          LDA     #$00
1007 B7  FF5C           00180          STA     $FF5C
100A 86  11             00190          LDA     #$11
```

Listing continued on page 28

Listing continued from page 27

```
100C B7   FF5C     00200          STA     $FF5C
100F 86   08       00210          LDA     #$08
1011 B7   FF5C     00220          STA     $FF5C
1014 86   00       00230          LDA     #$00
1016 B7   FF5C     00240          STA     $FF5C
1019 B7   FF5C     00250          STA     $FF5C
101C 86   12       00260          LDA     #$12
101E B7   FF5D     00270          STA     $FF5D
1021 B6   FF5D     00280 LOOP     LDA     $FF5D
1024 81   20       00290          CMPA    #$20
1026 27   F9       00300          BEQ     LOOP
1028 7E   1000     00310          JMP     START
                   00320 *
          0000     00330          END
00000 TOTAL ERRORS
LOOP    1021
START   1000
```

Listing 3. *Basic listing of the assembly program shown in Listing 2.*

```
10 DATA 86,0B,B7,FF,5D,86,00,B7
20 DATA FF,5C,86,11,B7,FF,5C,86
30 DATA 08,B7,FF,5C,86,00,B7,FF
40 DATA 5C,B7,FF,5C,86,12,B7,FF
50 DATA 5D,B6,FF,5D,81,20,27,F9
60 DATA 7E,10,00
70 A$="&H"
80 FORN=&H1000 TO &H102A
90 READB$
100 X=VAL(A$+B$)
110 POKEN,X
120 NEXT
130 EXEC&H1000
```

Glossary

bias field — a magnetic field applied to a thin magnetic film to reduce magnetic domains to bubbles.

boot loop — a special loop to map which loops are active and which are inactive, as found by factory testing.

bubble, magnetic — a cylindrical magnetic domain in a thin film of garnet; viewed from above it appears to be a bubble. It represents a binary 1.

chevron — one of many possible shapes for a metallic pattern deposited on a film of garnet to propel and steer bubbles.

detector — a device to distinguish bubbles from non-bubbles.

domain, magnetic — a small region of a ferromagnetic material containing similarly oriented atoms, so that the region is magnetized in one direction.

garnet — a naturally occuring silicate mineral. Synthetic garnet with similar crystal structure is made of oxides of lead and yttrium or other rare earths.

input track — a row of chevrons that leads bubbles from a generator to storage loop tracks.

latency — the delay between a request to read/write a memory address and the occurance of the operation, until that address arrives physically (not necessarily mechanically).

major loop — a loop with a generator, detector, or an annihilator, used to read/write data from/to a number of minor loops.

minor loop — an endless loop track for storing bubbles.

non-volatile — memory that retains data integrity with power shut off.

output track — a row of chevrons that lead bubbles from a storage loop to a bubble detector.

random access — memory whose access time to any bit is wholly independent of that bit's address.

serial access — memory whose access time to any bit is very dependent on that bit's address.

Listing 4. *All the 7220 control commands written as a series of subroutines. Once your bubble memory is complete, you can use these routines to experiment with bubble operation.*

```
                        00100 *
                        00110 * 7220 COMMAND SUBROUTINES
                        00120 * EACH ROUTINE WRITES A
                        00130 * SINGLE COMMAND TO THE
                        00140 * 7220 BUBBLE MEMORY
                        00150 * CONTROLLER
                        00160 *
1000                    00170          ORG     $1000
                        00180 *
                        00190 * WRITE BOOTLOOP REGISTER
                        00200 * MASKED
1000 86   10            00210 CMND0    LDA     #$10
1002 20   3A            00220          BRA     OUT
                        00230 * INITIALIZE COMMAND
1004 86   11            00240 CMND1    LDA     #$11
1006 20   36            00250          BRA     OUT
                        00260 * READ COMMAND
1008 86   12            00270 CMND2    LDA     #$12
100A 20   32            00280          BRA     OUT
                        00290 * WRITE COMMAND
100C 86   13            00300 CMND3    LDA     #$13
100E 20   2E            00310          BRA     OUT
                        00320 * READ SEEK COMMAND
1010 86   14            00330 CMND4    LDA     #$14
1012 20   2A            00340          BRA     OUT
                        00350 * READ BOOTLOOP REGISTER
                        00360 * COMMAND
1014 86   15            00370 CMND5    LDA     #$15
1016 20   26            00380          BRA     OUT
                        00390 * WRITE BOOTLOOP REGISTER
                        00400 * COMMAND
1018 86   16            00410 CMND6    LDA     #$16
101A 20   22            00420          BRA     OUT
                        00430 * WRITE BOOTLOOP COMMAND
101C 86   17            00440 CMND7    LDA     #$17
101E 20   1E            00450          BRA     OUT
                        00460 * READ FSA STATUS COMMAND
1020 86   18            00470 CMND8    LDA     #$18
1022 20   1A            00480          BRA     OUT
                        00490 * ABORT COMMAND
1024 86   19            00500 CMND9    LDA     #$19
1026 20   16            00510          BRA     OUT
                        00520 * WRITE SEEK COMMAND
1028 86   1A            00530 CMNDA    LDA     #$1A
102A 20   12            00540          BRA     OUT
                        00550 * READ BOOTLOOP COMMAND
102C 86   1B            00560 CMNDB    LDA     #$1B
102E 20   0E            00570          BRA     OUT
                        00580 * READ CORRECTED DATA
                        00590 * COMMAND
1030 86   1C            00600 CMNDC    LDA     #$1C
1032 20   0A            00610          BRA     OUT
                        00620 * FIFO RESET COMMAND
1034 86   1D            00630 CMNDD    LDA     #$1D
1036 20   06            00640          BRA     OUT
                        00650 * MBM PURGE COMMAND
1038 86   1E            00660 CMNDE    LDA     #$1E
103A 20   02            00670          BRA     OUT
                        00680 * SOFTWARE RESET COMMAND
103C 86   1F            00690 CMNDF    LDA     #$1F
103E B7   FF5D          00700 OUT      STA     $FF5D
1041 39                 00710          RTS
                        00720 *
          0000          00730          END
00000 TOTAL ERRORS
CMND0   1000            CMND8   1020
CMND1   1004            CMND9   1024
CMND2   1008            CMNDA   1028
CMND3   100C            CMNDB   102C
CMND4   1010            CMNDC   1030
CMND5   1014            CMNDD   1034
CMND6   1018            CMNDE   1038
CMND7   101C            CMNDF   103C
                        OUT     103E
```

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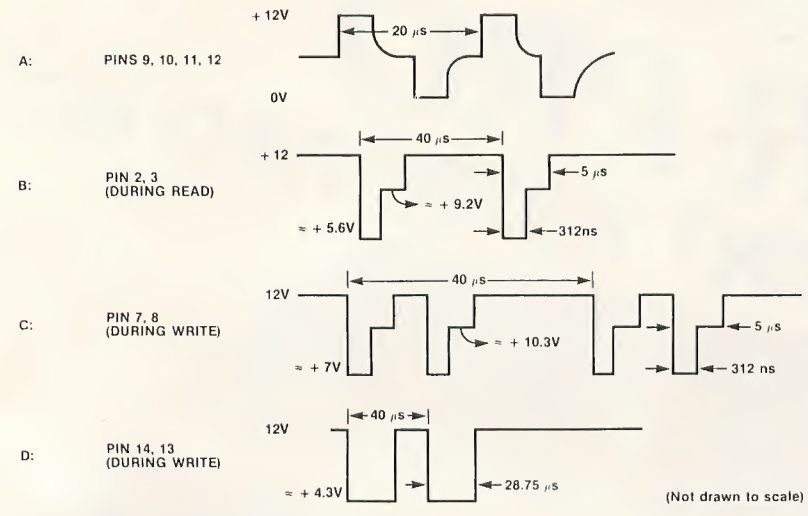
Continued from page 28

Figure 3. *Control signals that should be present on the 7110 bubble socket when Listing 2 or 3 is run. Use a 10-MHz oscilloscope for accurate display.*



spective, if I'm going to spend a few hundred dollars just to hold utility programs, it might as well be for the bubble system instead of a disk drive, which is slow and mechanical.

The disadvantage of the bubble is, of course, the cost of the 7110 bubble memories themselves. It's not likely you can afford to keep a shelf of them at $100 each. But then, the security of knowing your sensitive information is crash-free and protected from prying eyes might be convincing. And the cost might come down in the next few years. Intel predicts that by next year 1 megabyte of bubble storage will cost the same as 128K does today.

Updates

- Due to stresses on its supply system, Radio Shack can no longer offer the Extended Color Basic ROM at the Repair Center cost, as described in the March column. The ECB ROM will still be available on an exchange basis (only) with damaged ECB ROMs at the $67 price, and the ECB ROM kit can be purchased from Computer Centers, without installation or warranty, for $99.
- Due to quality control difficulties with external suppliers and manufacturers, projects appearing in this column will in the future be available from me directly, or from authorized dealers, under the Green Mountain Micro logo. Write to me at Green Mountain Micro, Roxbury, Vermont 05669, and ask for a catalog and dealer list.
- With reference to the above, the I/O port described in April and May should be in stock by the time you read this. My apologies for the delay. The Color Computer lowercase generator (Lowerkit), the TV Buff monitor output board, an updated Video Display Scroller, and the Bubble Memory Interface (Color Computer or Model III) are in stock.
- For the hundreds of readers who wrote asking for 64K upgrades and information on the 32K upgrades and other modifications for the newer NC-revision Color Computer, and for early C-revision boards, please have patience. I am preparing a complete rundown on this information for publication soon.
- Due to power failures during freak heavy spring snows in Vermont, this month's entire column was prepared on Radio Shack's new Model 100 portable computer. Congratulations to the Shack on their high tech breakthrough!
- During the next few months, look for plans for a complete lowercase and special character generator that fits compactly inside the Color Computer; a replacement keyboard project; an EPROM programmer; and a real-time clock. See you next month.

Bubble Memory Parts List

The BPK-72 bubble memory evaluation kit is available from Intel Magnetics, 3065 Bowers Avenue, Santa Clara, CA 95051. Contact the office of Steve Coney, NVMD Marketing, Mail Stop SC2-961; specify the BPK-72-4, which is the commercial temperature range (0 to 70 degrees C). The price is $299 for the complete kit.

The interface is available as a complete kit of parts and circuit board ($50) or assembled and tested ($100) from Green Mountain Micro, Roxbury, VT 05669, (802) 485-6112. The complete system (BPK-72, interface, and The Color BOSS — bubble operating system software by Jake Commander) is available for $550 from Green Mountain Micro.

Individual parts:

U1	74H04/F04 (*not* LS04!) hex inverter
U2	74LS74 dual flip-flop
U3	74LS00 quad 2-input NAND gate
U4	74LS32 quad 2-input OR gate
U5	74LS139 dual 2-of-4 demultiplexer
U6	2716 5-volt 2Kx8 EPROM
U7	7805 5-volt regulator
U8	7812 12-volt regulator
C1,C2	56 pF, 50V
C3	2200 mF, 50V
C4	100 mF, 35V
C5	100 mF, 35V
C6-C16	0.1 mF ceramic bypass
CR1	2A, 50V bridge rectifier
R1,R2	510 ohms, 1/4w
R3-R5	5.1k, 1/4w
T1	18 to 24 volt, 2A transformer
X1	8.000 MHz crystal

Miscellaneous: circuit board with male, 0.1-inch, 40-pin edge connector; 0.1-inch, 40-pin female card connector (for feed-through to disk, if desired); 0.156-inch, 44-pin female card connector; heat sinks for the regulators; sockets; solder; wire; hardware.

Technical Specifications

- Bubble memory manufacturer: Intel Corporation, Santa Clara, California.
- Interface manufacturer: Green Mountain Micro, Roxbury, Vermont.
- Operating system bootstrap and system routines in ROM from $E000 to $EFFF; expanded operating routines in the bubble.
- Bubble size: 1 Megabit (128K bytes), expandable by using 4 Megabit (512K bytes) bubble, which is pin-for-pin compatible. Also expandable by adding bubble (BPK-70) boards. Internal organization is 2048 loops, 512 bits/loop.
- Data transfer rate: Depending on software, up to 50K bytes per second.
- Average access time: 50 mS. System clock frequency is 4 MHz +/−0.1 percent.
- Power requirements: +12 volts, 400 mA; +5 volts, 400 mA (maximum); built-in powerfail detection.
- Operating temperature range: 0 to 70 degrees C.
- Cost: See parts list. ■■■

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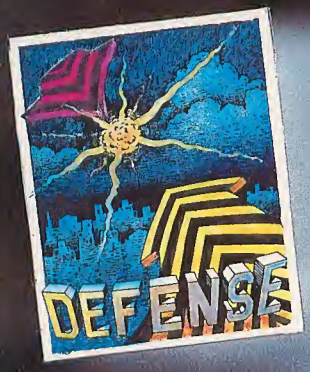

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The Sorcerer's Puzzles II

Having solved the first three puzzles, Poke and Sunshine's quest continues.

16K
Extended
Color
Basic

by Richard Ramella

THE STORY of the boy and girl, Poke and Sunflower, began in the April issue when they arrived at the Sorcerer's castle hoping to become apprentices. During the three months since their arrival at the castle, the twisted, malicious, and generally unpleasant keeper of the castle, Bob, has put them through several preliminary tests. The children have not yet even seen the Sorcerer.

"Good morning, good morning!" Bob greeted a sleepy Sunflower and Poke as they arrived for the usual porridge breakfast.

"Mrff," said Sunflower.

Poke slammed his spoon on the table. "Mush! I hate mush!"

"Now, now," Bob cautioned. "If you grubby young urchins want to become sorcerers, you must follow instructions exactly and with great humility. After you whitewash the east battlement of the castle you face more tests."

"For the jillionth time, when do we see the Sorcerer?" Sunflower asked.

Bob shrugged. "Perhaps when your work is done... perhaps on Michaelmas next. Who am I to presume knowledge of the Sorcerer's wondrous comings and goings?"

"I thought we were in for excitement and danger when we came here," Poke complained.

"Correct me if my ears play tricks," said Bob, "but did you say *excitement* and *danger*?"

"Pay no attention to Poke," said Sunflower.

"Oh, but I must. He'll get excitement and danger when he climbs the highest spire and paints it."

As he spoke, Bob smiled and turned to leave. Then he stopped in his tracks and fell with a shriek to the floor. Poke and Sunflower looked up. Standing in the doorway was a chubby, bald little man dressed in a rumpled corduroy suit.

"Hello," he said, "any mail arrive for me while I was gone?"

"Behold the mighty Sorcerer," Bob announced as he writhed on the floor.

The little man put one foot on Bob's prostrate form and lightly stepped over him, his hand extended. "I'm Donald E. Goldberg. Welcome to my castle."

"Do as he says and you won't get hurt," said Bob. "Don't anger him, for his wrath is awesome."

"Shush, Bob, and do get up off that cold floor."

"Yes, master. Thank you master." Bob leaped to his feet, a manic smile on his face, and stood fawning at the Sorcerer's elbow.

Sunflower quickly explained how she and Poke came to the castle to apprentice themselves to the Sorcerer. She noted they had already performed three tests. "And Bob was about to have us whitewash the castle."

The Sorcerer turned to Bob. "You were going to have these children *climb* the castle?"

Bob burst into tears. "Yes, yes, I admit it! I'm guilty! Turn me into a frog for a month, but please don't throw me in the briar patch!"

Sorcerer Goldberg frowned. "Bob, I think it might be good if you disappeared for a while." He snapped his fingers and Bob was gone. "Don't worry," the Sorcerer told the children, "I've just put him on hold."

Poke and Sunflower exchanged quick glances. There was no doubt about the Sorcerer's power. Sunflower asked, "Well, what about our becoming apprentices?"

Bob's voice was heard, though he couldn't be seen. "The girl has a smart mouth, master. The boy is stupid, but the girl has a tart tongue."

The Sorcerer winced and snapped his fingers again; Bob's voice faded. The little man eyed the pair for a moment. "Okay," he said, "you're now my apprentices."

"Wow!" said Poke.

"Surviving three months with Bob proves your worth," said the Sorcerer. "But I think we'll have a few more tests to determine your intelligence."

"Oh, we're really smart," Sunflower said.

The fat little Sorcerer pointed a finger at the wall and a panel opened. Out rolled a grand pedestal topped by a thick, aged book. "Behold *Wizardy Made Simple*," said the Sorcerer. "Turn to page 7,640, and you'll find the rules for Disappearing Act, Abecedarian and Turnabout. Try them..." And then like Bob, Sorcerer Goldberg vanished.

Disappearing Act

A three-by-seven grid is drawn. In the bottom two rows are 14 playing pieces, all orange except for the blue one in the bottom left square. In the top left square

is a green cursor that moves by pressing the four arrow keys. The object is to eliminate all playing pieces but one. Jumped pieces will disappear. Diagonal jumps are not allowed. To jump, position the green cursor over the piece that will jump, then tap N, W, E or S for the compass direction to be jumped. The jump must be over one piece into an empty square. For a double win, make the blue piece the last remaining and have the final jump leave it in the top left square.

Abecedarian

The letters A – X and an empty square are displayed in a five-by-five grid. The object is to put these 24 letters in alphabetical order, reading left to right in descending rows. Press the four arrow keys to maneuver letters. A legal move is one that slides a letter in the direction indicated by the arrow key tapped, filling the empty space in that direction. At the start, a player can choose from 10 to 1,000 displacement moves, and the starting position is already disordered. The program recognizes the winning position.

Turnabout

There will be a large color square on the screen. The object is to make the top half blue, the bottom half orange. The program recognizes a winning situation. As the program begins, the winning state is shown, then the two colors exchange. After that there is a series of exchanges of parts between the two blocks. This results in a random pattern. Move the blank cursor over the top half of the block by tapping the arrow keys. Press the space bar and blocks of colors on top and bottom exchange positions in a pattern. To solve the puzzle, you must determine where to place the blank cursor and press the space bar to make the top blue and the bottom orange. You are allowed 50 space bar taps.

For the solution or winning strategies, send a self-addressed, stamped envelope to Sorcerer's Puzzles Two, The Color Computer Magazine, *Highland Mill, Camden, Me. 04843. Canadians may send 40 cents coin and self-addressed envelope.*

■■■

Disappearing Act

```
100 REM *DISAPPEARING ACT* TRS-8
0 16K EXTENDED COLOR BASIC
110 REM * PRISMATIC PUZZLER #4 /
 RICHARD RAMELLA
120 CLS(0):P$=CHR$(143+80):U$=CH
R$(94):D$=CHR$(10):L$=CHR$(8):R$
=CHR$(9):R=96:S=224:T=352:PRINT@
7,"DISAPPEARING ACT";:W$=CHR$(14
3+64):O$=CHR$(143+112):B$=CHR$(1
28):FORA=0TO28:X$=X$+CHR$(143+64
):IFA/4=INT(A/4)THENA$=A$+CHR$(1
43+64)ELSEA$=A$+CHR$(128)
130 NEXT:FORA=32TO384STEP32:PRIN
T@A,A$;:NEXT:FORA=32TO416STEP128
:PRINT@A,X$;:NEXT:A$(1)=A$:Z$=W$
+B$+O$+B$:FORA=1TO7:A$(2)=A$(2)+
Z$:NEXT:A$(3)=A$(2):MID$(A$(3),3
,1)=CHR$(143+32):PRINT@R,A$(1);:
PRINT@S,A$(2);:PRINT@T,A$(3);:X=
98:A=1:B=3
140 A$=INKEY$:Q=0:PRINT@X,P$;:IF
A$<>D$ANDA$<>U$ANDA$<>R$ANDA$<>L
$ANDA$<>"N"ANDA$<>"W"ANDA$<>"S"A
NDA$<>"E"GOTO140ELSEIFA$=L$GOSUB
250ELSEIFA$=R$GOSUB260
150 IFQ=1ORA$=U$ANDX<123ORA$=D$A
NDX>353GOTO140
160 PRINT@X,B$;:IFA$=R$THENX=X+4
:B=B+4ELSEIFA$=L$THENX=X-4:B=B-4
ELSEIFA$=U$THENX=X-128:A=A-1ELSE
IFA$=D$THENX=X+128:A=A+1
170 PRINT@X,P$;:PRINT@R,A$(1);:P
RINT@S,A$(2);:PRINT@T,A$(3);:PRI
NT@X,P$;
180 IFA$="S"ANDX<123ANDMID$(A$(1
),B,1)<>B$ANDMID$(A$(3),B,1)=B$A
NDMID$(A$(2),B,1)<>B$THENMID$(A$
(3),B,1)=MID$(A$(1),B,1)::MID$(A
$(1),B,1)=B$:MID$(A$(2),B,1)=B$:
V=V+1
190 IFA$="N"ANDX>353ANDMID$(A$(3
),B,1)<>B$ANDMID$(A$(1),B,1)=B$A
NDMID$(A$(2),B,1)<>B$THENMID$(A$
(1),B,1)=MID$(A$(3),B,1):MID$(A$
(2),B,1)=B$:MID$(A$(3),B,1)=B$:V
=V+1
200 IFB<10GOTO210ELSEIFA$="W"AND
MID$(A$(A),B-4,1)<>B$ANDMID$(A$(
A),B-8,1)=B$ANDMID$(A$(A),B,1)<>
B$THENMID$(A$(A),B-8)=MID$(A$(A)
,B,1):MID$(A$(A),B-4)=B$:MID$(A$
(A),B,1)=B$:V=V+1
210 IFB>19GOTO220ELSEIFA$="E"AND
MID$(A$(A),B+4,1)<>B$ANDMID$(A$(
A),B+8,1)=B$ANDMID$(A$(A),B,1)<>
B$THENMID$(A$(A),B+8,1)=MID$(A$(
A),B,1):MID$(A$(A),B+4,1)=B$:MID
$(A$(A),B,1)=B$:V=V+1
220 PRINT@R,A$(1);:PRINT@S,A$(2)
;:PRINT@T,A$(3);:PRINT@480,"SCOR
E:";V;:IFV<13GOTO140
230 IFMID$(A$(1),3,1)=CHR$(143+3
2)THENPRINT@480,"DOUBLE ";
240 PRINT@490," WINNER ";:FORT=1
TO3:SOUND89,2:NEXT:SOUND125,2:FO
RT=1TO2:SOUND147,2:SOUND125,2:NE
XT:FORT=1TO5:NEXT:GOTO240
250 IFX=98ORX=226ORX=354THENQ=1:
RETURNELSERETURN
260 IFX=122ORX=250ORX=378THENQ=1
:RETURNELSERETURN:END
```

Abecedarian

```
100 REM * ABECEDARIAN / 16K EXTE
NDED COLOR BASIC
110 REM * PRISMATIC PUZZLER #5 /
 RICHARD RAMELLA
120 CLS(0):CLEAR600:PRINT@262,"
A B E C E D A R I A N ";:FORT=1T
O1000:NEXT:FORT=1TO50:PRINT@RND(
128)+223,CHR$(RND(26)+64);CHR$(1
43+RND(7)*16);:SOUNDRND(8)*20,1:
NEXT:FORT=1TO1000:NEXT:P$="ABCDE
FGHIJKLMNOPQRSTUVWX"+CHR$(128)
130 CLS0:PRINT"YOU NEAR THE ABEC
EDARIAN TEST.":PRINT"HOW MANY DI
SPLACEMENTS,":PRINT"FROM 10 TO 1
000":INPUTM:IFM>1000THENM=200ELS
EIFM<10THENM=10
140 CLS(0):DIMA$(11):C$=CHR$(128
):U$=CHR$(94):H$=CHR$(10):L$=CHR
$(8):R$=CHR$(9):FORA=1TO21:D$=D$
+CHR$(143+32):NEXT:FORA=1TO10:E$
=E$+CHR$(128):NEXT:A$="LDJIVEQHB
XUKARCWFNSGPMTO"+C$:C$=C$+CHR$(1
43+32)+C$:FORA=1TO25:B$=B$+MID$(
A$,A,1)+C$:NEXT:B=1
150 FORA=1TO81STEP20:A$(B)=C$+MI
D$(B$,A,20):B=B+1:NEXT:A$(10)=A$
(5):A$(8)=A$(4):A$(6)=A$(3):A$(4
)=A$(2):A$(2)=A$(1):FORA=1TO11ST
EP2:A$(A)=D$:NEXT:FORA=1TO11:A$(
A)=E$+A$(A):PRINTA$(A);:NEXT:A=1
0:B=30:C$=CHR$(128):FORF=1TOM:PR
INT@480,"DISPLACE:"F;
160 J=RND(4):IFJ=1ANDK=2ORJ=2AND
K=1ORJ=3ANDK=4ORJ=4ANDK=3GOTO160
ELSEK=J:IFJ=1THENZ$=H$ELSEIFJ=2T
HENZ$=U$ELSEIFJ=3THENZ$=L$ELSEIF
J=4THENZ$=R$
170 GOTO200
180 NEXT:PRINT@480,"TIME TO PLAY
";:N=1
190 Z$=INKEY$
200 IFA=2GOTO210ELSEIFZ$=H$THENM
ID$(A$(A),B,1)=MID$(A$(A-2),B,1)
:MID$(A$(A-2),B,1)=C$: A=A-2
210 IFA=10GOTO220ELSEIFZ$=U$THEN
MID$(A$(A),B,1)=MID$(A$(A+2),B,1
):MID$(A$(A+2),B,1)=C$:A=A+2
220 IFB=14GOTO230ELSEIFZ$=R$THEN
MID$(A$(A),B,1)=MID$(A$(A),B-4,1
):MID$(A$(A),B-4,1)=C$:B=B-4
230 IFB=30GOTO240ELSEIFZ$=L$THEN
MID$(A$(A),B,1)=MID$(A$(A),B+4,1
):MID$(A$(A),B+4,1)=C$:B=B+4
240 PRINT@0,"";:FORX=1TO11:PRINT
A$(X);:NEXT:IFN=0GOTO180ELSEFORY
```

```
=2TO10STEP2:FORS=14TO30STEP4:Q$=
Q$+MID$(A$(Y),S,1):NEXTS:NEXTY
250 IFQ$=P$THENPRINT@480,"  WINN
ER";:SOUND100,1:GOTO250ELSEQ$=""
:GOTO190:END
```

Turnabout

```
100 REM*TURNABOUT*TRS-80 16K EXT
ENDED COLOR BASIC
110 REM * PRISMATIC PUZZLER #6 /
 RICHARD RAMELLA
120 CLS0:PRINT@236,"TURNABOUT ";
:CLEAR550:FORA=1TO128:A$=A$+CHR$
(143+112):B$=B$+CHR$(143+32):NEX
T:E$=B$:FORA=1TO3:G(A)=RND(6):NE
XT:A=32:P=1
130 PRINT@32,B$;A$;:PRINT@320,"T
HIS IS YOUR GOAL.";:FORT=1TO2000
:NEXT:CLS0:PRINT@32,A$;B$;:PRINT
@320,"BUT IT STARTS THIS WAY.":F
ORT=1TO2000:NEXT:PRINT"AND THEN
IT GETS MIXED UP."
140 S=50:FORT=1TORND(10):P=RND(1
28):K=RND(4):GOSUB200:PRINT@32,A
$;B$;:NEXT:K=0:P=1:PRINT@480,"YO
U HAVE 50 MOVES ";:FORT=1TO1500:
NEXT:FORT=320TO510:PRINT@T,CHR$(
128);:NEXT
150 C$=INKEY$:PRINT@448,"MOVES L
EFT";S;
160 PRINT@480,"TOP";CHR$(143+32)
;" BOTTOM";CHR$(143+112);:IFC$=C
HR$(94)ANDA>63THENA=A-32:P=P-32E
LSEIFC$=CHR$(10)ANDA<128THENA=A+
32:P=P+32ELSEIFC$=CHR$(8)ANDA/32
<>INT(A/32)THENA=A-1:P=P-1ELSEIF
C$=CHR$(9)AND(A-31)/32<>INT((A-3
1)/32)THENA=A+1:P=P+1
170 PRINT@A,CHR$(128);:FORT=1TO2
0:NEXTT:PRINT@32,A$;B$;:IFC$=CHR
$(32)GOSUB190
180 GOTO150
190 S=S-1:K=K+1
200 IFK=1THENW=2ELSEIFK=2THENW=4
ELSEIFK=3THENW=8ELSEIFK=4THENW=1
6:K=0
210 FORJ=P TO LEN(A$)STEPW:L$=MI
D$(A$,J,1):MID$(A$,J,1)=MID$(B$,
J,1):MID$(B$,J,1)=L$:NEXT
220 IFA$<>E$THENRETURN
230 PRINT@32,A$;B$;:F$=CHR$(128)
+"WINNER"+CHR$(128)
240 FORX=320TO344:PRINT@X,F$;:SO
UNDX-150,1:NEXT:FORX=344TO320STE
P-1:PRINT@X,F$;:SOUNDX-150,1:NEX
T:GOTO240
```

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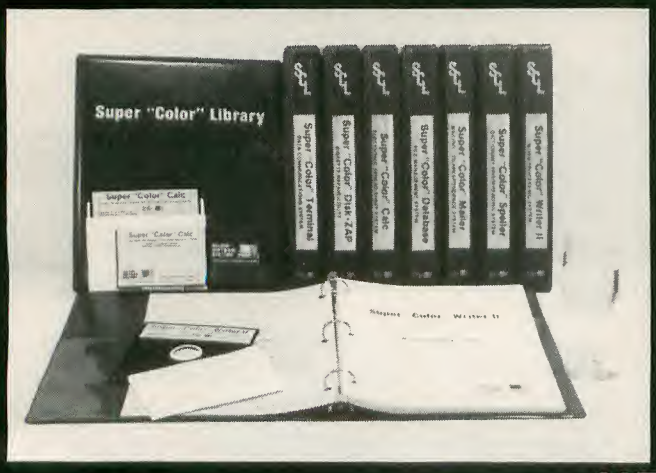

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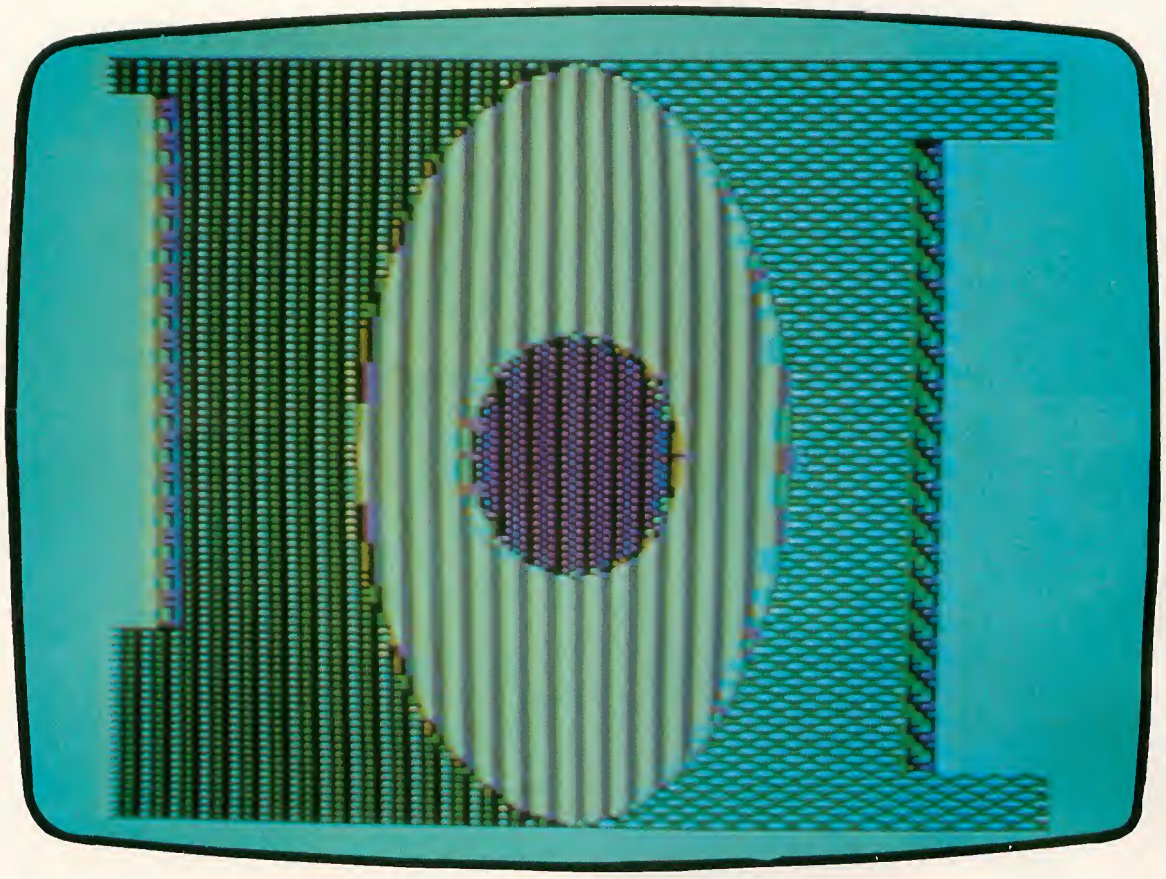

16K Extended Color Basic

DYE It!

by H. Allen Curtis

NUMEROUS PROGRAMS and articles demonstrate that there are many colors besides buff and black in color set 1 of PMODE 4. Knowing this, aren't you dissatisfied with Basic's PAINT command? Wouldn't you like to be able to use a PAINT-like command that permits you to use each of the existing colors and color patterns? This article will make such a command available to you in a very convenient way.

The new command is called the DYE command. DYE, like PAINT, is an aptly chosen word to describe its function — to color objects. The syntax for DYE is as follows:

DYE(x,y,c,k,r)

- x specifies an X-coordinate and is a numeric expression from 0 to 255.
- y specifies a Y-coordinate and is a numeric expression from 0 to 191.
- c specifies the color code for every odd line DYEd and is a numeric expression from 0 to 255.
- k specifies the color code for every even line DYEd and is a numeric expression from 0 to 255.
- r specifies the rotate code and can change c and k; r is a numeric expression from 0 to 7.

The expressions x and y specify X - and Y - coordinates precisely the same way as similar expressions do in the PAINT command.

The color codes 0 and 255 of c or k represent black and buff, respectively. Codes between 0 and 255 represent an array of colors and color patterns too varied to describe and list in detail. The codes 85 and 170 represent the solid color patterns cyan and orange or orange and cyan, respectively. Which code represents which of these two colors depends on the starting state of your Color Computer.

The rotate code r treats c and k as binary numbers and rotates them right r positions. The first line DYEd is always in c's color with c unrotated. The second line DYEd is always in k's color with k unrotated. The code c is rotated r positions right for every succeeding odd line DYEd. Likewise, the code k is rotated r positions right for every succeeding even line DYEd. Note that for $5 \leq r \leq 7$, r is equivalent to a left rotate of $8 - r$ positions. Suppose $c = 23$, $k = 170$, and $r = 1$. Table 1 shows the codes of the colors in the first 10 lines DYEd.

The expressions x, y, c, k and r have the same properties as those presented in George Fraser's *TRS-80 Microcomputer News* article, "Texture," (June, 1982). This is no coincidence since Fraser's article was the inspiration for mine. A short, two-line Basic program with a machine language subroutine embedded in it adds the DYE command to your Color

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Program Listing 1

```
10 X=256*PEEK(27)+PEEK(28)-429
20 FORI=X TOX+428:READA$:A=VAL("
&H"+A$):POKEI,A:B=B+A:NEXT
30 DATA44,59,C5,30,8C,FA,CE,1,3F
,FF,1,35,C6,3,BD,A5,9A,8E,1,37
40 DATA6F,1D,6C,1D,33,8C,9,EF,81
,33,4F,EF,1,6F,5,39,81,D0,25,3
50 DATA7E,B2,77,8E,1,3A,80,CE,7E
,AD,D4,BD,B2,6A,86,4,97,7D,BD
60 DATAB7,3D,34,10,32,61,BD,B2,6
D,A,7D,26,F2,BD,B7,3D,9F,43,35
70 DATA16,DD,42,D7,45,BD,B2,67,1
F,10,C6,20,3D,D3,BA,1F,3,1F,10
80 DATA1F,98,C6,2,D7,7E,5F,4D,2A
,4,88,80,C6,10,80,8,2B,3,5C,20
90 DATAF9,8B,8,44,1F,2,8E,0,1F,9
F,51,F,50,1F,31,DC,BA,C3,17,E1
100 DATAFD,1,DA,1F,20,BC,1,DA,25
,1,39,3A,E6,84,C1,FF,27,35,4D,27
110 DATA5,58,58,4A,26,FB,C4,C0,C
1,C0,27,24,1F,20,D,50,2B,F,26,2
120 DATAD7,50,D1,51,24,10,5A,86,
3,1F,2,20,C4,D1,52,26,1,39,5C,4F
130 DATA20,F3,D6,50,3,50,20,F1,1
F,20,4D,27,4D,81,3,27,49,C6,FC
140 DATAE4,84,C1,FC,27,41,C6,3F,
E4,84,C1,3F,27,39,4A,26,20,C6
150 DATAF0,E4,84,C1,F0,27,2E,86,
CF,8D,D,86,C,A4,84,81,C,26,7B
160 DATA8D,2,20,77,43,9A,45,A4,8
4,A7,84,39,C6,F,E4,84,C1,F,27
170 DATAE,86,F3,8D,ED,86,30,A4,8
4,81,30,26,5B,20,DE,1F,20,5D,27
180 DATA9,A6,82,5A,81,FF,26,2,20
,F4,D7,51,CC,3,3,97,7C,96,7C,A4
190 DATA84,91,7C,26,9,8D,C3,8,7C
,8,7C,5A,26,EF,D6,51,5C,30,1,A6
200 DATA84,81,FF,26,8,96,45,A7,8
4,C1,1F,26,EF,D7,52,DB,51,57,C9
210 DATA0,4F,1F,2,CC,C0,3,97,7C,
96,7C,A4,84,91,7C,26,9,8D,90,4
220 DATA7C,4,7C,5A,26,EF,33,C8,2
0,A,7E,27,15,96,7D,26,6,C,7D,96
230 DATA42,20,4,F,7D,96,43,97,45
,1F,20,16,FE,EC,86,2,97,7E,D6
240 DATA44,27,E3,34,4,DC,42,46,6
,42,56,6,43,35,4,5A,26,F1,20,D2
300 IFB<>44133THENCLS:PRINT"YOU
HAVE TYPED A VALUE OR VALUESINCO
RRECTLY IN ONE OR MORE DATA STAT
EMENTS."
```

Continued from page 39

Table 1

Code	Binary Form	Line DYEd
23	00010111	1
170	10101010	2
139	10001011	3
85	01010101	4
197	11000101	5
170	10101010	6
226	11100010	7
85	01010101	8
113	01110001	9
170	10101010	10

Computer's Basic repertoire. This program is called DYE SETTER. When you have loaded SETTER into the computer, you then will be able to compose and run your own programs using the DYE command. DYE SETTER becomes a part of each program you write. When you load your program (having previously saved it), it will run as though DYE had been an original command in the Color Computer's repertoire.

Generating DYE SETTER

DYE SETTER is generated using a three step process. The first step, though short, is the most important, so take care in performing it. After you have turned on your computer, carefully type:

```
POKE 27,1+PEEK(27): POKE28,173+
PEEK(28)
```

When you are sure you have typed the line correctly, press Enter. You have just freed 429 bytes of RAM located immediately after any Basic program that you key in and immediately before the memory storing variables for that program. The 429-byte RAM area is protected from being overwritten by the Basic interpreter and is the place where the machine language portion of DYE SETTER will be located.

It is worth noting that when you turn on your Color Computer, address 28 always contains the number 3. If you wish to free 509 bytes of RAM, you would have to set the contents of address 28 to 0 and then add 2 to the contents of address 27.

The second step of the process is POKEing the machine language portion of DYE SETTER into the freed RAM area. To perform this step, key in Listing 1 or Listing 2. Those of you with cassette-based systems should use Listing 1; those with Radio Shack disk-based systems should use Listing 2. After you have typed the program, run it. If you get an OD error message, check your DATA statements to see what value or values you omitted. Or, if you receive the message, YOU HAVE TYPED A VALUE OR VALUES INCORRECTLY IN ONE OR MORE DATA STATEMENTS, check the DATA statements and correct your mistakes. Then rerun the program. When the program runs without an error message of any kind, the machine language routine is correctly located in the freed memory area.

For the third step, type:

```
DEL 20–
```

and press Enter. Then type and Enter this line:

```
20 DEFUSR=X+3:X=USR(0)
```

You have now generated DYE SETTER. Save it on tape or disk depending on whether your system is cassette or disk based. DYE SETTER works with both 16K or 32K RAMs.

Any time you load DYE SETTER from tape or disk be sure to run DYE SETTER before you add any lines of Basic programming that contain DYE commands. Otherwise, your computer will not recognize the word DYE as a command, and you will receive a BS error message at any line containing the DYE command.

Adding the DYE command to Basic's repertoire places one restriction on cassette based systems: except for the USR of line 20, you must not use USR, USR1 or USR2.

Using the DYE Command

With DYE SETTER still resident in your Color Computer, you can experiment with the DYE command via a few illustrative examples:

Example 1: Key in the following four lines:

```
30  PMODE4,1:PCLS1:SCREEN1,1:
    COLOR0,1
40  LINE(10,10)–(239,171),PSET,B
50  DYE(125,11,23,170,1)
500 GOTO500
```

Then type RUN and press Enter. The first thing you will notice is that, like all good dyes, the DYE command is fast. In fact, the DYE command will color an object about 35 times faster than the PAINT command.

In the example, c, k, and r were assigned the values associated with Table

Please turn to page 44

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Program Listing 2

```
10 X=256*PEEK(27)+PEEK(28)-429
20 FORI=X TOX+428:READA$:A=VAL("
&H"+A$):POKEI,A:B=B+A:NEXT
30 DATA44,59,C5,30,8C,FA,CE,1,49
,FF,1,3F,C6,3,BD,A5,9A,8E,1,41
40 DATA6F,1D,6C,1D,33,8C,9,EF,81
,33,4F,EF,1,6F,5,39,81,E3,25,3
50 DATA7E,B2,77,8E,1,44,80,E1,7E
,AD,D4,BD,B2,6A,86,4,97,7D,BD
60 DATAB7,3D,34,10,32,61,BD,B2,6
D,A,7D,26,F2,BD,B7,3D,9F,43,35
70 DATA16,DD,42,D7,45,BD,B2,67,1
F,10,C6,20,3D,D3,BA,1F,3,1F,10
80 DATA1F,98,C6,2,D7,7E,5F,4D,2A
,4,88,80,C6,10,80,8,2B,3,5C,20
90 DATAF9,8B,8,44,1F,2,8E,0,1F,9
F,51,F,50,1F,31,DC,BA,C3,17,E1
100 DATAFD,1,DA,1F,20,BC,1,DA,25
,1,39,3A,E6,84,C1,FF,27,35,4D,27
110 DATA5,58,58,4A,26,FB,C4,C0,C
1,C0,27,24,1F,20,D,50,2B,F,26,2
120 DATAD7,50,D1,51,24,10,5A,86,
3,1F,2,20,C4,D1,52,26,1,39,5C,4F
130 DATA20,F3,D6,50,3,50,20,F1,1
F,20,4D,27,4D,81,3,27,49,C6,FC
140 DATAE4,84,C1,FC,27,41,C6,3F,
E4,84,C1,3F,27,39,4A,26,20,C6
150 DATAF0,E4,84,C1,F0,27,2E,86,
CF,8D,D,86,C,A4,84,81,C,26,7B
160 DATA8D,2,20,77,43,9A,45,A4,8
4,A7,84,39,C6,F,E4,84,C1,F,27
170 DATAE,86,F3,8D,ED,86,30,A4,8
4,81,30,26,5B,20,DE,1F,20,5D,27
180 DATA9,A6,82,5A,81,FF,26,2,20
,F4,D7,51,CC,3,3,97,7C,96,7C,A4
190 DATA84,91,7C,26,9,8D,C3,8,7C
,8,7C,5A,26,EF,D6,51,5C,30,1,A6
200 DATA84,81,FF,26,8,96,45,A7,8
4,C1,1F,26,EF,D7,52,DB,51,57,C9
210 DATA0,4F,1F,2,CC,C0,3,97,7C,
96,7C,A4,84,91,7C,26,9,8D,90,4
220 DATA7C,4,7C,5A,26,EF,33,C8,2
0,A,7E,27,15,96,7D,26,6,C,7D,96
230 DATA42,20,4,F,7D,96,43,97,45
,1F,20,16,FE,EC,86,2,97,7E,D6
240 DATA44,27,E3,34,4,DC,42,46,6
,42,56,6,43,35,4,5A,26,F1,20,D2
300 IFB<>44211THENCLS:PRINT"YOU
HAVE TYPED A VALUE OR VALUESINCO
RRECTLY IN ONE OR MORE DATA STAT
EMENTS."
```

Continued from page 41

1. To get an idea of the plethora of colors and patterns available to you, assign to c, k and r a series of different values. Although r has only been defined for values 0 – 7, the DYE command will accept values from 0 – 255. However, the higher values of r will not provide any patterns not generated by using 0 – 7; using high values for r slows the DYE commands operation. New values are assigned to c, k and r by EDITing the last three values of the DYE command in line 50. For solid cyan or orange, for instance, assign 85 or 170 to c and k with r set to 0.

When you are finished playing with the c, k, and r codes, consider the y code. In line 50 change the y code from 11 to 95 and see what happens when you run the program. The DYE command, unlike PAINT, always colors objects from top to bottom. The x code, in general, depends on the value assigned to y. Usually, the x code is a value representing approximately the midpoint of the first line DYEd. Of course, for a rectangle, x is the same for any value of y.

Example 2: Replace lines 40 and 50 of Example 1 with the following:

```
40 X=128:Y=96:CIRCLE(X,Y), 30
50 C=68:K=1:R=0
60 DYE(X,Y-28,C,K,R)
```

Note that the values in the DYE command are specified in variable form. They were given in constant form in Example 1. Either form or a mixture is permitted. After you run the program, you will notice that the color pattern covering the circle is fuzzy at the boundaries. This is the case for most color patterns.

Example 3: Save Example 2 depending on which version of DYE SETTER you are using. After you have recorded a good copy of the program, turn off your computer. Then turn your computer back on and load the program. Now, LIST it. Look at line 60 in particular. Don't worry about the exclamation point where DYE should be. Run the program and you'll see that it executes as it did in Example 2. LIST the program again and note that DYE now appears in line 60.

Example 4: Add the following line to Example 2 or 3:

```
25 PCLEAR5
```

Then change PMODE4,1 in line 30 to PMODE4,2 and run the program. You will probably receive an ?SN error at line 30. If so, rerun the program and it will then execute properly. This example shows that you are not restricted to using the first four video pages. To use the DYE command the background color must always be buff.

Example 5: Add the following lines to Example 4:

```
70 CIRCLE(X,Y),60,,1.6
80 C=95:K=C:DYE(X,Y-94,C,K,R)
90 DYE(X-32,Y-30,C,K,R)
```

Now run it. Note that the space between the ellipse and the circle was colored using two DYE commands. The first command did most of the work; it colored all but the space to the left of the circle, and the second DYE command took care of that.

Example 6: Add the following lines to Example 5:

```
100 LINE(14,10)-(18,140),PSET,B
110 C=C+1:K=K+10:R=2
120 DYE(16,11,C,K,R)
```

then run the program. This example shows that DYE can be used to cover narrow objects.

For narrow objects the value of x is determined as follows: Let A and B represent the X-coordinates of the left and right boundaries, respectively, of the object at the Y-coordinate specified by y. Then $x \geq 8 + 8*INT(A/8)$, and $x \leq B - 2$. This means that how narrow a "DYEable" object can be depends on its position on the screen. For instance, suppose A = 219, then $x \geq 8 + 8*INT(219/8) = 224$. The smallest B can be is 226 when x = 224. Therefore, the narrowest object with A = 219 has a right boundary B at a distance 7 from A. To verify this, add these lines to the program:

```
130 LINE(219,20)–(226,175), PSET,B
140 DYE(224,21,C,K,R)
```

Then run the program. Now, change the right boundary B from 226 to 225 in line 130 and note what happens when you run the program.

Example 7: This is the concluding example. It shows that you can use DYE outside of objects as well as inside them. Replace the value 225 in line 130 with the original value 226. Then add these two lines and run the program:

```
150 DYE(25,1,0,50,0)
160 DYE(200,1,0,250,4)
```

Concluding Remark

If you tried all seven examples, you should be ready to write your first PMODE 4 program using the DYE command. So, go DYE it, the PAINTless way.

■ ■ ■

Skyline Software

PUBLISHERS OF QUALITY MICROCOMPUTER SOFTWARE

PAGE PLUS — Attention BASIC programmers! Here is the software you've been waiting for! Up to 56K available from your BASIC programs. This utility, written by Chris Hawks, does the memory management necessary to utilize the two 32K banks of memory. Easy enough for any 'intermediate' level BASIC programmer to use. Includes documentation and demo programs to show you how to use PAGE PLUS to get the most out of your computer. Works with 64K tape or disk systems.
Cassette $27.95 **Disk $29.95**

MDISK — Hal Snyder's latest breakthrough for the 64K Color Computer! MDISK lets you use the upper 32K of memory for rapid storage and retrieval of programs and data. Whether you own an actual disk drive or not, MDISK puts the 'hidden' 32K to work for you as a 'virtual disk,' with capability to save and load up to 15 programs, view a directory of files stored in 'page 1', kill unwanted page 1 files, execute BASIC or machine language directly from MDISK, chain to a BASIC program while preserving data already created, and more. These functions are available not only under manual keyboard control, but from programs in progress as well, permitting high-speed swapping of programs or data. Unlike many 64K utilities, MDISK doesn't copy BASIC to RAM. This greatly increases the amount of workspace available to you (by 22K in a disk system). MDISK is written in position independent code, and will work on disk or tape based 64K systems. Full documentation included.
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ROMBACK — Why pay more? The easiest to use ROM-pak dumping utility available! At the best price, too! Comes with full documentaion, including detailed patching instructions to allow several popular 'problem' cartridges to run from tape or disk. Stop plugging and unplugging your disk controller! Don't blow any more SAM chips or 6809Es! Use ROMBACK, and run those programs from tape or disk instead. Works with any 64K Extended BASIC tape or disk system.
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QUICKSORT — A machine language sort routine specifically designed to be used by BASIC programmers. This utility will speed up those programs where a BASIC sort is just too slow. Great for mailing lists and databases. Can be incorporated into many existing programs as well. Written in position independent code, works on tape or disk systems. 16K required.
Casette $12.95

64K BOOT/PAGER — Two 'must have' utilities for the 64K Color Computer owner. The 64K Boot allows you to modify BASIC by moving it from ROM to RAM. The PAGER is a menu-driven utility allowing you to manually page between the 32K banks of memory, copying BASIC or data from one page to the other. The complete assembler source code for both programs is included, so you can see how it's done! Both programs are written in position independent code and run on 64K tape or disk systems.
Cassette $19.95

STRUCTURED MACROS — An assembly language programming tool for users of the Macro-80C assembler, by the Micro Works. Structured macros come close to transforming your assembler into a high-level language. Your programs become more understandable and debugging is simplified. Commands include IF, ELS, ENDIF, IFTST, IFCC, WHILE, ENDWH, REPEAT, and UNTIL.
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Damage Report, Mr. Scott

CC Space Trek corrected for Extended Color Basic.

by Jamie Tietjen and Jake Commander

STARFLEET COMMAND Engineering Change Notice CC40.5 10-60.66, Stardate 8305.02.
SUBJECT: Uprated Cadet Fleet Scanner Display — Revised installation procedures.
FROM: Starfleet Chief Engineer Tietjen. **TO:** All Cadet Fleet Installation Engineers.

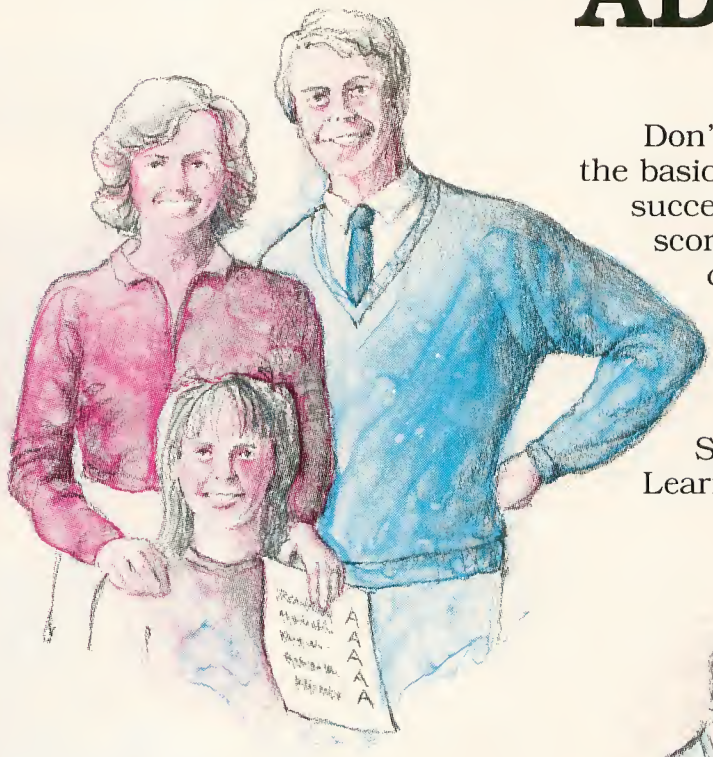
It has been determined from initial field reports that uprated scanner displays will give erroneous reports or completely fail to initialize (preventing operation of other sensing systems) when lack of Communication Cassettes forces manual installation. The source of this fault occurs from unexpected Disk Token data presented for translation during initialization using the Basic Interpreter tokenization technique. These Disk Tokens are not translated at all by Extended Basic systems, and result in improper operation of the final "quote" stage of initialization.

Revision 1.1 involves replacing initialization code (Lines 10–60) with the code listing included with this notice, plus the temporary initialization code lines 65 and 66. This code should not be altered or expanded in any way, as it is position dependant. The first trial run of the initialization should produce a normal Scanner display, and may be verified by checking for proper translation of code line 60. The first placeholding Token (appearing as *) should translate to a quotation mark ("), and those following should become exclamation points (!).

Proper initialization may be followed by deleting code lines 65 and 66 to shorten system initialization. If this is done, it should be followed by a system back-up command (CSAVE). All systems should become active and return to normal status.

```
10 CLEAR250:SB=PEEK(25)*256+PEEK
(26):FORX=1TO5:READZ:POKESB+Z,34
:NEXT:DATA78,119,149,193,237
20 A$=*FNFNFNFNFNFNUSINGUSINGF
NUSINGFNUSINGFNUSINGFNUSINGFNUSI
NGFNUSINGFNUSINGFN*FNFNFNFNFNFNF
N
30 B$=**FORFORFORFORFORFORFORFOR
FORFORFORFORFORFORFORFORUSING
40 L$(1)=**CONTPAINT*CONTPAINT*C
LOADPCOPY*CLOADPAINT*CONTPCOPY*C
LOADPAINT*CONTPCOPY*CLOADPAINT*C
ONTPAINT*CONTPAINT*CONT
50 L$(2)=*CONTPAINT*CONTPAINT*CO
NTPCOPY*CONTPCOPY*CLOADPAINT*CON
TPCOPY*CLOADPAINT*CONTPCOPY*LLIS
TPAINT*CONTPAINT*CONTPAINT
60 L$(3)=*PAINT*CONTPAINT*CONTPA
INT*CLOADPAINT*CONTPCOPY*CLOADPA
INT*CONTPCOPY*CLOADPAINT*CONTREN
UM*CONTPAINT*CONTPAINT*
65 FORY=1TO34:READX,Z:POKESB+X,Z
:NEXT:DATA103,206,120,206,150,21
1,153,211,156,211,159,211,162,21
5,165,211,168,215,171,211,174,21
9,177,211,180,211,196,211,199,21
1,202,215,205,211,208,215,211,21
1,214,215,217,211,220,211,223,21
1,239,211,242,211,245,215
66 DATA248,215,251,211,254,215,2
57,211,260,215,263,211,266,211,2
69,211
```

GIVE YOUR CHILD AN UNFAIR ADVANTAGE



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PERSONALIZED INSTRUCTION ON PERSONAL COMPUTERS

Family Outing— Computer Style!

Visit a Color Computer users group.

by Tim and Debra Cole

PEOPLE OF ALL AGES, sizes and occupations file through the double doors of the Holiday Inn that lead into the meeting area. They proceed to the tables where they begin to set up the hardware and equipment they've brought with them in preparation for the start of the monthly meeting of the Color Computer Club of Youngstown, Ohio.

A line forms in the hallway outside, and at this rate, it's apparent that the room will soon be filled beyond capacity as members and guests continue to cart their portable televisions, cassette recorders and notebooks past the cluttered table where Ginny Komara, club treasurer, and Phil Lucido, president, are checking off names on the ledger sheet and collecting the $1 cover charge as well as the yearly dues. Ginny points out that this is the first time since the club was founded that it has been necessary to set a fee for attending a session. But this is also the first time the club has met at the Holiday Inn, and the room costs money.

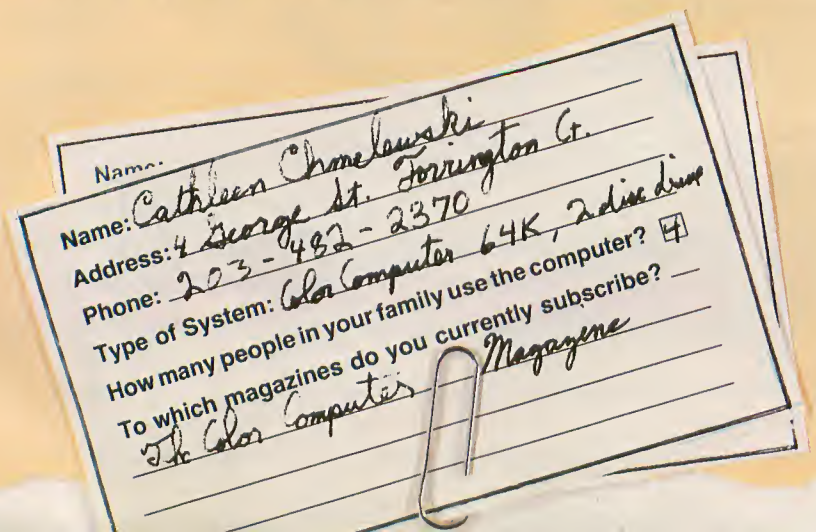
Originally, Ginny explains, the group got together in the back room of a Radio Shack, then they moved on to occupy the basement of the Hobby House before outgrowing both of those rent-free quarters. It seems that this single section of an expandable conference room is not going to be large enough to contain the increasing number of people waiting at the door.

Tim McFadden, former president of the club, comes late because of his work schedule, but the assembly waits for his arrival before starting the proceedings. Tim is the founder of the organization and, though not currently an officer, is still a main force behind it. All this madness, he says, indicating the melange of mortals and machinery, is the result of a spur of the moment inspiration that came about when a handful of enthusiastic people got together one day after a visit to the Canton, Ohio, Radio Shack. They decided to gather everyone they knew who owned Color Computers to join forces in order to help one another and share their experiences.

From a stark framework of 23 individuals 1 1/2 years ago, they've built the membership to over 100 people, and the number increases each month. All of this is by word of mouth, too. They've never advertised their existence, though area computer shops are aware of them and sometimes pass on the information to new customers.

Since Tim has arrived and found a spot in the back of the room, and the scene at the tables has begun to resemble pre-launch countdown at the Houston Manned Spacecraft Center, Phil makes his way to the front of the crowded room.

The room becomes silent as machines are switched off and the rows of chairs neatly arranged in the center of the floor are filled first come, first served. The President takes his place in front of the congregation. Robert's Rules are tailored to




REMEMBE

fit the informality of the group and the session begins.

A few minutes are set aside to discuss old business, then Phil addresses those who have just dropped by in order to see how a club like this works. (All guests are welcome to attend twice free of charge, but the club does ask a dollar fee after that.) He explains that the Color Computer Club is an organization devoted to promoting the use of the Color Computer. For those who may have just purchased a machine or are not quite sure how to run one, beginners' classes are offered and taught at specified times by the club's veteran members. No one needs feel that he must be an expert to enjoy his computer or that he has to rely on manuals and salespeople to help him figure out what he is doing.

The annual dues, he continues, are only $15 per membership. A membership can be just one person or an entire family. (We can think of very few places an entire family can go, be together for a few hours on a weekend, and share a good time for only $15 a year. It's sort of a McDonald's for the mind.)

Bob Sherman speaks next, he's head of the club's educational subcommittee. He is a man who takes his responsibilities seriously and he stresses the idea of bringing the Color Computer into area schools to demonstrate how beneficial these machines can be as learning and teaching tools.

The next subject for discussion under the educational topic is the acquisition of more material for the club's program library. The library is a catalogued collection of programs either written by members or used with the "expressed written consent of the copyright owners." (The club is adamant about protecting copyrights and discourages members from copying material not their own for any purpose.)

After a short discussion, Phil reclaims the floor and makes a motion that the fund-raising drive for the Easter Seals Telethon be repeated. They held one last year when several members got together at a local shopping mall and donated their time and machines to the cause by setting up different arcade-types of games on each screen and charging passers-by 25 cents a game to play. Every penny was donated to the Easter Seals charity. The motion passes easily.

Next on the agenda is the nominations for club offices. Any member is permitted to run for office providing he or she has attended at least one third of the meetings held since his or her membership began. The elections are held one year prior to the time those elected take office, in order to give them a chance to learn their jobs through a period of apprenticeship before taking over their new positions.

It's been about half an hour and a member makes the motion that the general meeting be adjourned. Motion seconded and passed. Everyone stands at once, and most of the people mingle briefly before moving off to user's groups around the room. Now, the screens glow and everything from simple games to complex mathematical problems mystically claim the attention of those fleet-fingered pilots at the keyboards as well as those backseat operators who are ever ready with instructions, advice and questions.

In one corner, a group of youngsters play "Desert Sands" while across the room, Bill Taylor, a journeyman electrician from GM Packard, tries to explain his machine to us. He's been interested in computers since 1975, and started out on a home-built 6502 microprocessor. From there he went to the C24P, then on to the C1P. He now has a TRS-80 Color Computer. He's written a number of technical articles on the computer and obviously knows the workings well.

"It's astonishing the number of uses people find for the Color Computer."

A few feet away ten-year-old Larry Cadman, a student at Kirkmer elementary, plays chess with his machine. The machine wins — this time.

In one corner, two women discuss the new question and answer feature in the club's monthly newsletter and how it will help them. Now, when someone has a problem, he can deposit that question in a box and it will be answered in the following month's bulletin. That way others with the same difficulty can benefit from the orgainzation's collective experience.

Amid the talking, beeping, clattering, zapping, laughing, ringing and all the other sounds that make a bona fide din, the educational subcommittee attempts to hold its own meeting around a table commandeered in the center of the room. Chairman Sherman outlines, briefly, (for our benefit) the four basics of the committee:

The first is to enchance the Color Computer's use as a learning tool by reviewing or rewriting educational programs. The second is to present the members of the club with a demonstration of some educational program or service. The third goal is to organize community involvement projects such as taking club members into area schools to demonstrate the computer. (They've already done this several times and with great success. Three principals from various schools are in the room to learn more about the Color Computer and its potential.) Finally they are in charge of coordinating educational classes for the club members.

We leave the meeting in progress to wander over to a front corner of the room where we find the program library wedged between the blackboard and the coat rack. Here, tapes are filed into three categories: utility, game, and educational. Members are allowed to check out one tape per membership per month for reviewing. With the high unemployment in this particular area of the country it's amazing that so many people update their libraries at all, and no one wants to get stuck with something he can't use once he gets it home. Borrowing helps a member find out in advance whether a particular program can help or be of interest before purchasing. Again, the club stresses that taping these programs is forbidden.

The Color Computer Club issues a program library index to members complete with index number, name of program, type of program, memory, N-E-M, and description of each item offered as a guide. Even as we watch, the box that holds the tapes empties and assistant librarians, Gene DiRenzo and Judy Valerio, scribble names and pass out material as fast as they can.

From time to time members stop to chat, eager to talk about how they feel about their machines. It's astonishing the number of uses people found for the Color Computer. One woman uses it to keep a running record of her shopping list, the students say it's invaluable when doing homework (not to mention the hours of game playing time available), and everyone finds it a handy checkbook balancer.

In no time at all, four o'clock has rolled around, and, without a signal of anykind, machines are gradually, reluctantly, shut down, unplugged, and packed away as members straggle out the door a few at a time. We are all set to follow when one of the officers asks what insight we've gathered about the way members feel toward their club. The answer is simple. We've never seen such a cooperative group of diverse individuals with so much enthusiasm or so much interest in any one thing. The whole visit was our pleasure. ■ ■ ■

Telewriter-64™

the Color Computer Word Processor

- **3 display formats: 51/64/85 columns × 24 lines**
- **True lower case characters**
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Simply stated, Telewriter is the most powerful word processor you can buy for the TRS-80 Color Computer. The original Telewriter has received rave reviews in every major Color Computer and TRS-80 magazine, as well as enthusiastic praise from thousands of satisfied owners. And rightly so.

The standard Color Computer display of 32 characters by 16 lines without lower case is simply inadequate for serious word processing. The checkerboard letters and tiny lines give you no feel for how your writing looks or reads. Telewriter gives the Color Computer a 51 column by 24 line screen display with *true lower case characters*. So a Telewriter screen looks like a printed page, with a good chunk of text on screen at one time. In fact, more on screen text than you'd get with Apple II, Atari, TI, Vic or TRS-80 Model III.

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Telewriter's chain printing feature means that the size of your text is never limited by the amount of memory you have, and Telewriter's advanced cassette handler gives you a powerful word processor without the major additional cost of a disk.

...one of the best programs for the Color Computer I have seen...
— Color Computer News, Jan. 1982

TELEWRITER-64

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Telewriter-64 runs fully in any Color Computer — 16K, 32K, or 64K, with or without Extended Basic, with disk or cassette or both. It automatically configures itself to take optimum advantage of all available memory. That means that when you upgrade your memory, the Telewriter-64 text buffer grows accordingly. In a 64K cassette based system, for example, you get about 40K of memory to store text. So you don't need disk or FLEX to put all your 64K to work immediately.

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Besides the original 51 column screen, Telewriter-64 now gives you 2 additional high-density displays: 64 × 24 and 85 × 24!! Both high density modes provide all the standard Telewriter editing capabilities, and you can switch instantly to any of the 3 formats with a single control key command.

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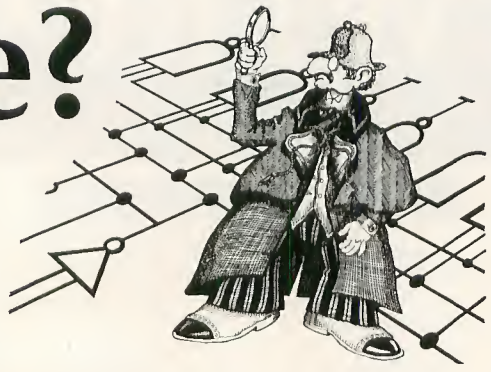
GOTO Where?

16K Color Basic



A debugging aid for Basic programs.

by D.E. Wood

GOTOXREF ANALYZES a Basic program and tells you which lines are called and from where they are called.

The program examines each byte of the program you want analyzed (I'll call this the target program), and searches for all occurrences of the Basic commands GOTO, RUN, GOSUB, ELSE, and THEN. It reads the line numbers called by these commands and the numbers of the lines containing the calls; this information is stored in a string array. The first five characters of each string record the number of a called line; the rest of the string records the lines from which that line is called. For example, if lines 50, 70, 500, and 1000 call line 100 of a program, then one string in the array would be:

00100 50, 70, 500, 1000

Table 1.

Instructions for appending one program to the end of another with a cassette-based system.

To gain the maximum amount of available memory, CLOAD the first program and type: POKE 25 , 6 : NEW ENTER

- Step 1. Type: PRINT PEEK (25), PEEK (26) ENTER

Make a note of the two numbers printed

- Step 2. Type: PRINT PEEK (27), PEEK (28) ENTER

If PEEK (28) is greater than 1, go to Step 5

- Step 3. Type: POKE 25, PEEK (27)−1 : POKE 26, PEEK (28) + 254 ENTER

Go to Step 6

- Step 4. Type: POKE 25, PEEK (27) : POKE 26, PEEK (28)−2 ENTER
- Step 5. CLOAD the second program.

If the first line of this program does not have a higher number than the last line of the program loaded in Step 1, use the renumber function to give it higher line numbers. The first program will not be affected by a renumber at this point.

- Step 6. Type: POKE 25, the first value noted in Step 2 Enter POKE 26, the second value noted in Step 2 ENTER

To use GOTOXREF, key in Program Listing 1 and save it to tape or disk. Then load the target program and append GOTOXREF to the end of that program. Table 1 shows how to combine two programs on a cassette-based system.

When the two programs are combined, Enter: RUN 60000. Line 60015 of GOTOXREF asks you for a range of line numbers: I'll explain this later. For now, just press Enter in response to both queries.

When the entire program has been examined, the program sorts the array into called-line order which appears on the screen as shown in the Sample Run.

If your target program is very long and contains many calls, you may find there isn't enough string space available to record all the calls. This appears as an O/S Error (out of string space), after GOTO XREF has been working for some time.

This is where the From and To queries in line 60015 can be useful. Assume that the target program has line numbers from 0–10000, fairly evenly distributed over this range. If GOTOXREF bombs out because of an O/S or B/S (bad subscript) error, run it again, but this time specify a range from 0–5000. GOTOXREF will examine your entire program, but will only save and display calls to lines within the range of 0–5000. Since calls to lines outside this range are not recorded, you'll use less string space. When you have extracted the information you want, Enter: RUN 60000 again and specify a range of 5001–10000. GOTOXREF then picks up the calls it ignored in the previous run. It takes twice as long to analyze a program this way, but it does get the job done.

If you have a printer, substitute Program Listing 2 for lines 60600–60605. This gives a nicely formatted printout.

That's all you need to know to use GOTOXREF. The rest of this article describes in detail how it works.

Initialization

Line 60005 reserves as much memory as possible for string storage, leaving 800 bytes for program operation. L$( ) is the string array that records the called lines and the lines they are called from. A separate element of this array is assigned to each line called. Strings cannot be more than 255 characters long, so if a particular line is called from many other lines, there may not be enough room for all the calls in one string. In this situation, the program assigns a second string to that called line.

RAM locations 25 and 26 record where the Basic program memory starts. The variable X represents the memory location being PEEKed at. Line 60010 initializes X two bytes before the beginning of your target program. Line 60100 immediately increments X by one, so the first PEEK is at the byte immediately preceding the target program.

Subroutine

The subroutine at lines 60400–60410 PEEKs at byte X and makes G equal to the value stored in this byte. Line 60405 skips over any spaces (ASCII code 32) in your target program. This is necessary because GOTOXREF looks for a line number immediately after a Call command. If your program had a space between a GOTO and a line number, the call would be missed unless the space was ignored.

The Search

Basic commands are stored in memory in a compressed format, using one or two bytes to represent the entire command rather than one byte for each character in the command. GOTOXREF looks for bytes containing values of 129 and 165 (which represent GOTO), 129 and

Table 2.

Explanation of Variables.

A The program line currently being examined
A$ Line number A, converted to a string
C The number of elements of the L$( ) array used so far
F2 Flag in the sort routine
G The value stored in memory location X
L$( ) String array that records each called line, and the lines it's called from
Q Counter in FOR...NEXT loops to create, sort, and display the L$( ) array
S$ String used to store the line number following a call
S1 Lowest line number to search for
S2 Highest line number to search for
T$ Temporary storage in sort routine
X Memory location currently being examined
X$ Dummy string for INPUT statements in line 60605
Y Dimension of the L$( ) array

166 (GOSUB), 142 (RUN), 132 (ELSE), and 167 (THEN).

The fact that not all bytes with the above values represent Basic commands complicates the search for calls. Line pointers (the first two bytes of each line), and line numbers (the third and fourth bytes of each line), can contain values anywhere from 0–225. Fortunately, the last byte of every line contains a zero, as does the byte immediately before the beginning of a program. When I refer to a zero, it's the value stored in a byte, not the character zero, which may be part of your program's text. In a program statement such as IF X = 0 THEN Y = 5, a byte containing a value of 48 (the ASCII code for 0) represents the character 0. In a Basic program, the only places zero value bytes can be found are at a line end, and maybe in one or more of the pointer or line number bytes.

When line 60105 finds a zero, line 60110 calculates the next line number and increments X by four, to skip over the pointer and line number bytes.

Now that pointers and line numbers are out of the way, lines 60125–60127 test for the call commands. If they find one, line 60135 examines the bytes that follow, and if the bytes are numerical, stores them in S$. If no line number follows the command, as may be the case with RUN, ELSE, and THEN, S$ remains a null string and control passes to 60105 to search for another call command. If S$ does contain a number, 60145 tests to see if it is within the range of line numbers specified by the operator in answer to the queries in line 60015.

The Array

If S$ contains a line number within the proper range, then 60200 lengthens it to five characters by adding leading zeros as required. This is necessary because the sort and display routines operate on the basis that the called line numbers occupy the first five characters of each string in the array.

Line 60205 defines A$ as the string form of A, the line in which the call was located. A FOR...NEXT loop is then established to examine the L$( ) array.

If the array doesn't contain a string devoted to calls to S$, then 60225 gives this job to the first null string in the array and records the call from A$.

If an array element for calls to line S$ exists, then 60215 tests to see if a call from line A$ has already been recorded. If it has, it's not recorded again. So for a line such as

10 ON X GOTO 20, 30, 20, 20, 50

10 would be recorded only once on the string for calls to line 20. This saves string space and produces a shorter, neater display. You may prefer to show that line 20 was called three times from line 10. If so, delete line 60215.

Line 60220 checks to see if the array element devoted to calls to line S$ is too long to accept another call. If this is so, the loop continues and searches for another string devoted to S$. If there isn't another string, line 60225 creates one.

If an L$(Q) element has been assigned to calls to line S$, and a call from line A$ hasn't been recorded yet, and L$(Q) is not too long, then 60220 adds A$ to the end of L$(Q).

The Search Continues

After processing a call, and if necessary, recording it in the array, line 60300 looks for a comma after the called line number. The routine branches to 60105 to search for another call if no comma is found. If 60300 finds a comma, GOTOXREF must be PEEKing at an ON...GOTO or ON...GOSUB statement, so control passes to 60130 to search for another line number.

The End

The search ends when 60115 encounters the first line of GOTOXREF. All that remains is a simple bubble sort (lines 60500–60510) and the display (lines 60600 and 60605). The display shows one string at a time; press Enter to see the next one. The display is an endless loop so you'll have to press Break to escape.

To test GOTOXREF on itself, add 63000 REM and change the 59999 in lines 60015 and 60115 to 62999. The sample run shows GOTOXREF's analysis of itself.

Many thanks to Mel Seder for his help in writing and testing this routine. ■■■

Sample Run

60100	IS CALLED FROM	60120, 60125, 60128
60105	IS CALLED FROM	60140, 60300
60125	IS CALLED FROM	60105
60130	IS CALLED FROM	60126, 60127, 60300
60135	IS CALLED FROM	60135
60200	IS CALLED FROM	60200
60225	IS CALLED FROM	60210
60300	IS CALLED FROM	60145, 60215, 60220
60400	IS CALLED FROM	60105, 60127, 60135, 60300, 60405
60500	IS CALLED FROM	60115
60505	IS CALLED FROM	60510
60600	IS CALLED FROM	60605

Listing 1

```
60000 PRINT "GOTOXREF"
60001 REM D. WOOD, R. I. A.
60005 CLEAR 0 : CLEAR MEM - 800
60010 Y = 100 : DIM L$(Y) : X =
PEEK(25) * 256 + PEEK(26) - 2
60015 INPUT "FROM";S1 : INPUT "T
O";S2 : IF S2= 0 THEN S2= 59999
60100 X= X + 1
60105 GOSUB 60400 : IF G > 0 THE
N 60125
60110 X= X + 4 : A= PEEK(X-1) *
256 + PEEK(X)
60115 IF A > 59999 THEN 60500
60120 PRINT : PRINT "LINE NO. ";
 A ; " CALLS"; : GOTO 60100
60125 IF G<>129 AND G<>142 AND G
<>132 AND G<>167 THEN 60100
60126 IF G<>129 THEN 60130
60127 X= X + 1 : GOSUB 60400 : I
F G= 165 OR G= 166 THEN 60130
60128 GOTO 60100
60130 X= X + 1 : S$= ""
60135 GOSUB 60400 : IF G > 47 AN
D G < 58 THEN S$= S$ + CHR$(G) :
 X= X + 1 : GOTO 60135
60140 IF S$= "" THEN 60105 ELSE
PRINT "," ; S$ ;
60145 IF VAL(S$) < S1 OR VAL(S$)
 > S2 THEN 60300
60200 IF LEN(S$) < 5 THEN S$= "0
" + S$ : GOTO 60200
60205 A$=STR$(A) : FOR Q=0 TO C
60210 IF LEFT$( L$(Q), 5) <> S$
THEN NEXT Q : GOTO 60225
60215 IF RIGHT$( L$(Q), LEN(A$))
= A$ THEN 60300
60220 IF LEN( L$(Q)) + LEN( A$)
< 255 THEN L$(Q)= L$(Q) + "," +
A$ : GOTO 60300 ELSE NEXT Q
60225 L$(Q)= S$ + A$ : C= C + 1
60300 GOSUB 60400 : IF G= 44 THE
N 60130 ELSE 60105
60400 G= PEEK(X)
60405 IF G= 32 THEN X= X + 1 : G
OTO 60400
60410 RETURN
60500 PRINT : PRINT "SORTING"
60505 F2= 0 : FOR Q= 1 TO C - 1
: IF L$(Q) > L$(Q + 1) THEN T$=
L$(Q) : L$(Q)= L$(Q + 1) : L$(Q
+ 1)= T$ : F2= 1
60510 NEXT Q:IF F2=1 THEN 60505
60600 CLS : FOR Q= 1 TO C : PRIN
T "LINE NO. " ; VAL( LEFT$( L$(Q
), 5)) ; " IS CALLED FROM" ; RIG
HT$( L$(Q), LEN( L$(Q)) - 5)
60605 INPUT X$ : NEXT Q : PRINT
"FINISHED" : INPUT X$ : GOTO 606
00
```

Listing 2

```
60600 CLS : FOR Q= 1 TO C : PRIN
T#-2, "LINE NO. " ; VAL(LEFT$( L
$(Q), 5)) ; " IS CALLED FROM" ;
RIGHT$( L$(Q), LEN( L$(Q)) - 5)
60605 NEXT Q : PRINT "FINISHED"
: INPUT X$ : GOTO 60600
```

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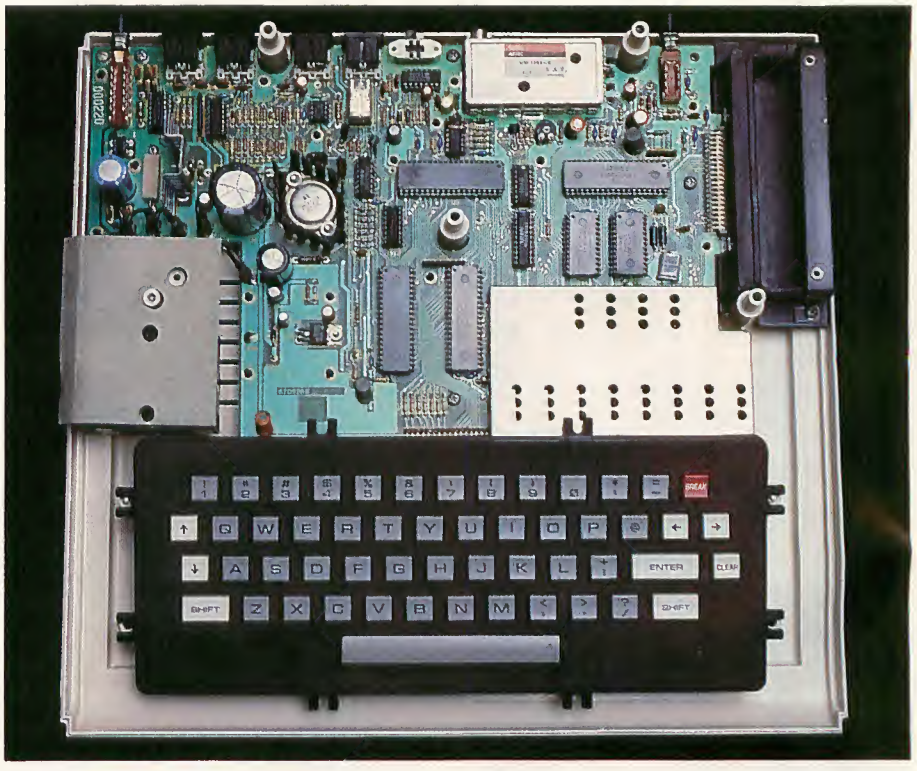
Dissecting Your ROM

Color Basic ROM explained. The first of 12 articles.

by Jake Commander



IT ALWAYS HAPPENS the same way; I get a new microcomputer and there's something I need to know. The only trouble is, it's never, *ever,* in the manual. I guess that's the price you pay for having an inquisitive mind. Shortly after I bought my Color Computer, I took a long, tortuous trip into its brains. This was all brought about by innocently wondering if I could get the Color Computer to read tapes from my TRS-80 Model I. It didn't seem an unreasonable proposal (and is quite possible). However, at the time I was hoping the tape formats would be more similar than they turned out to be.

How did I find that out? By looking in the manual? Not likely. The only way was to disassemble the ROM and try to find the code that performed the tape I/O (input/output). It sounded so simple, but there were a few minor obstacles in the way. First, I didn't have a disassembler. Second, I had no knowledge of 6809 machine code so I couldn't have understood a disassembly anyway.

Crazy though it may sound, this situation had advantages. If I really wanted that tape I/O information from ROM, I had to learn 6809 machine code pretty fast and follow it up by writing a disassembler to plod through the code.

As you'll find if you face a similar situation, writing a disassembler is just about the fastest way there is of learning the machine code for a particular MPU (also known as CPU). I'd already discovered this from disassembling the Model I's ROM and found it gave me a crash course on the Z-80. The same was about to happen with the 6809.

That sets the scene for what you're about to see over the next months in **The Color Computer Magazine**. As I said before, this whole project began by trying to find what made the tape I/O tick. Before finding that information, I had unraveled half the original 8K Color Basic 1.0 ROM. It was only natural to complete the job and have a good reference in front of me. Next thing I knew, I'd upgraded to Extended Color Basic and my curiosity took over again. (I'd improved the disassembler itself and that was a good way to try it.) Bear in mind that the comments will be rather cryptic in certain places. There are two reasons for this: it was originally intended only for my personal use so the comments were kept short and to the point. Also, it had to be done fast so I could keep an overall picture in mind, so some of the comments reflect that speed.

Each month I'll cover a little more than 1K of disassembly, which will build up to a full reference on the whole 16K of Extended Color Basic. At the start of each article, I'll make a comment or two on what that part of the ROM is doing, but as the series is to be for reference, expect it to be more or less a stand-alone column.

The disassembly is just the way you'd get it by using the disassembler presented last month, with one exception. Relative branches are shown jumping to absolute addresses in order to leave more space in the comments column. Where the code isn't really machine code but is ASCII text or tables, the comments will make this clear. No attempt is made to clean up the disassembly to make it appear more like source code. It will look just as output from the disassembler looks.

Where trick pieces of code are used, this will be commented, too. For instance, it's possible to jump into the middle of certain op codes and have a different instruction carried out than appears in the disassembly. An example of this is the code at $A304 which appears as CMPX #$9E97. Notice that if this code is jumped to at location &A305, the MPU will execute a LDX <$97 instruction. This can be used by a sneaky machine code programmer to mask certain code. It isn't done for secrecy, but it saves a jump over the unwanted op code. Once again this will be commented where it occurs.

All this may give a false impression. The comments are not at their most useful at each and every op code. They give the best idea of the working of the code when you take a step back. Like an artist viewing his work, too close a view doesn't give the right picture. So, don't take each commented op code too literally, but try to get a picture of each section of code that performs a particular function. That's another reason why some comments remain cryptic.

So here we go: Round One. This portion of ROM deals with power-up and reset. Also covered is keyboard input, plus video and RS-232 output. ■■■

Listing begins on page 56.

```
00002  A000 A1 C1        ;POLCAT (poll keyboard for character)
00003  A002 A2 82        ;CHROUT (output character to DEVNUM)
00004  A004 A7 7C        ;CSRDON (start cassette)
00005  A006 A7 0B        ;BLKIN  (read cassette block)
00006  A008 A7 F4        ;BLKOUT (write cassette block)
00007  A00A A9 DE        ;JOYIN  (read joysticks)
00008  A00C A7 D8        ;WRTLDR (write cassette leader)

Initialization Routine
00009  A00E 10 CE 03D7   LDS   #$03D7    ;Temporary Stack Pointer
00010  A012 86 37        LDA   #$37      ;Enable the
00011  A014 B7 FF23      STA   $FF23     ;Cartridge
00012  A017 96 71        LDA   <$71      ;Already set up?
00013  A019 81 55        CMPA  #$55
00014  A01B 26 51        BNE   $A06E     ;If not, do startup
00015  A01D 9E 72        LDX   <$72      ;Else possible jump - X
00016  A01F A6 84        LDA   0,X       ;Jump destination...
00017  A021 81 12        CMPA  #$12      ;....= NOP?
00018  A023 26 49        BNE   $A06E     ;If not, start Color BASIC
00019  A025 6E 84        JMP   0,X       ;Otherwise jump to the NOP.

Startup routines for PIA's, VDG, SAM
00020  A027 CE A00E      LDU   #$A00E    ;Setup the return address
00021  A02A 5F           CLRB            ;for page zero.
00022  A02B 1F 9B        TFR   B,DPR     ;Set direct page register.
00023  A02D 8E FF00      LDX   #$FF00    ;=> PIA U8 (Keyboard PIA setup)
00024  A030 6F 01        CLR   1,X       ;Clear PIA control registers.
00025  A032 6F 03        CLR   3,X
00026  A034 6F 84        CLR   ,X        ;Clear the keyboard row.
00027  A036 CC FF34      LDD   #$FF34    ;Load A=$FF, and B=$34.
00028  A039 A7 02        STA   2,X       ;"Clear" the keyboard columns.
00029  A03B E7 01        STB   1,X       ;Set the control registers
00030  A03D E7 03        STB   3,X
00031  A03F 8E FF20      LDX   #$FF20    ;=> PIA U4 (Inp/Outp PIA setup).
00032  A042 6F 01        CLR   1,X       ;Clear the PIA control registers
00033  A044 6F 03        CLR   3,X
00034  A046 4A           DECA            ;A now equals $FE
00035  A047 A7 84        STA   0,X       ;Reset tape Input, RS232 Output.
                                         ;Set Digital/Analog converter.
00036  A049 86 F8        LDA   #$F8
00037  A04B A7 02        STA   2,X       ;Set up Video Display Generator.
00038  A04D E7 01        STB   1,X       ;Set the control registers.
00039  A04F E7 03        STB   3,X
00040  A051 6F 02        CLR   2,X       ;Clear the VDG.
00041  A053 86 02        LDA   #2
00042  A055 A7 84        STA   0,X       ;Set RS232 to data Output.
00043  A057 A6 02        LDA   2,X       ;Get memory size bit.
00044  A059 8E FFC0      LDX   #$FFC0    ;=> SAM reset lines.
00045  A05C C6 10        LDB   #$10      ;(16 addresses.)
00046  A05E A7 81        STA   ,X++      ;Reset SAM.
00047  A060 5A           DECB            ;Are all 16 done?
00048  A061 26 FB        BNE   $A05E     ;Repeat 'til all 16 addr reset.
00049  A063 B7 FFC9      STA   $FFC9     ;Set display to address $0400.
00050  A066 84 04        ANDA  #4        ;This a 16K RAM size computer?
00051  A068 27 02        BEQ   $A06C     ;-> If not, jump to $A06C.
00052  A06A A7 1B        STA   -5,X      ;Send memory size to SAM.
00053  A06C 6E C4        JMP   ,U        ;Jump to return address

Color BASIC startup
00054  A06E 8E 0000      LDX   #0
00113  A0FC BD A7D1      JSR   $A7D1     ;cassette on delay (twice).
00114  A0FF BD A7D1      JSR   $A7D1
00115  A102 CE A108      LDU   #$A108    ;Return address.
00116  A105 7E A02A      JMP   $A02A     ;Reset PIA's and SAM.
00117  A108 0F 71        CLR   <$71      ;Reset Level 1 "Startup" flag.
00118  A10A 7E C000      JMP   $C000     ;Go to ROMPACK

ROM REFLECTIONS.
At Startup, these values are transferred from ROM
to RAM page zero starting from location 008F.
00119  A10D 12           NOP             ;Wavelength reference.
00120  A10E 18                           ;Upper allowed cass. wavelength.
00121  A10F 0A 00        DEC   <0        ;Lower allowed cass. wavelength.
                                         ;and # of bytes at header (128).
00122  A111 80 0B        SUBA  #$0B      ;Flash cursor, & flash counter.
00123  A113 00 57        NEG   <$57      ;Baud Rate delay.
00124  A115 00 01        NEG   <1        ;Baud Rate line delay.
00125  A117 1070                        ;Lprinter Col. Width & Max Tab.
00126  A119 84 00        ANDA  #0        ;Lprinter Chars/line & print pos
00127  A11B B4 4A0C      ANDA  $4A0C     ;"CLOADM" entry point. Beginning
00128  A11E A7 26        STA   6,Y       ;  of character parsing loop.
00129  A120 02                          ;
00130  A121 0C A6        INC   <$A6
00131  A123 B6 0000      LDA   0         ;Parse pointer.
00132  A126 7E AA1A      JMP   $AA1A     ;continue parse in ROM.
00133  A129 7E A9B3      JMP   $A9B3     ;IRQ
00134  A12C 7E A0F6      JMP   $A0F6     ;FIRQ
00135  A12F 7E B44A      JMP   $B44A     ;FC ERROR (USR vector)
00136  A132 80 4F        SUBA  #$4F
00137  A134 C7
00138  A135 52
00139  A136 59           ROLB
00140  A137 FF 045E      STU   $045E
00141  A13A 7E B277      JMP   $B277
00142  A13D 35 AA        PULS  A,DPR,Y,PC
00143  A13F 66 AB        ROR   D,Y
00144  A141 67 14        ASR   -$0C,X
00145  A143 AB 1A        ADDA  -6,X
00146  A145 AA 29        ORA   9,Y
00147  A147 43           COMA            ;C
00148  A148 4F           CLRA            ;O
00149  A149 4C           INCA            ;L
00150  A14A 4F           CLRA            ;O
00151  A14B 52                           ;R
00152  A14C 20 42        BRA   $A190     ; B
00153  A14E 41                           ;A
00154  A14F 53           COMB            ;S
00155  A150 49           ROLA            ;I
00156  A151 43           COMA            ;C
00157  A152 20 31        BRA   $A185     ; 1
00158  A154 2E 30        BGT   $A186     ;.0
00159  A156 0D 28        TST   <$28      ; (
00160  A158 43           COMA            ;C
00161  A159 29 20        BVS   $A17B     ;)
00162  A15B 31 39        LEAY  -7,Y      ;19
00163  A15D 38                           ;8
00164  A15E 30 20        LEAX  0,Y       ;0
00165  A160 54           LSRB            ;T
00166  A161 41                           ;A
00167  A162 4E                           ;N
```

```
00055  A071 6F 80        CLR   ,X+        ;Set first 1K of RAM to zeros.
00056  A073 8C 0400      CMPX  #$0400
00057  A076 26 F9        BNE   $A071
00058  A078 BD A928      JSR   $A928       ;Jump to CLS (clear the screen).
00059  A07B 8E A10D      LDX   #$A10D      ;=> Source byte address.
00060  A07E CE 008F      LDU   #$008F      ;=> Destination
00061  A081 C6 1C        LDB   #$1C        ;28 bytes
00062  A083 BD A59A      JSR   $A59A       ;copy (X)->(U)
00063  A086 CE 010C      LDU   #$010C      ;destination
00064  A089 C6 1E        LDB   #$1E        ;30 bytes
00065  A08B BD A59A      JSR   $A59A       ;copy (X)->(U)
00066  A08E 8E B277      LDX   #$B277      ;SN ERROR vector
00067  A091 AF 43        STX   3,U         ;>$B4 token vector
00068  A093 AF 48        STX   8,U         ;>$93 function interpret
00069  A095 8E 015E      LDX   #$015E
00070  A098 86 39        LDA   #$39        ;=RTS opcode
00071  A09A A7 80        STA   ,X+         ;* block off
00072  A09C 8C 01A9      CMPX  #$01A9      ;* extended BASIC
00073  A09F 26 F9        BNE   $A09A       ;* jump vectors
00074  A0A1 B7 02D9      STA   $02D9
00075  A0A4 8E 0600      LDX   #$0600      ;=> 1st BASIC addr
00076  A0A7 6F 80        CLR   ,X+         ;clear BASIC start
00077  A0A9 9F 19        STX   <$19        ;save BASIC start pointer
00078  A0AB A6 02        LDA   2,X         ;byte from memory
00079  A0AD 43           COMA              ;change it
00080  A0AE A7 02        STA   2,X         ;try to replace
00081  A0B0 A1 02        CMPA  2,X         ;gone in OK?
00082  A0B2 26 06        BNE   $A0BA       ;if not, this is mem end
00083  A0B4 30 01        LEAX  1,X         ;bump memory pointer
00084  A0B6 63 01        COM   1,X         ;reset RAM value
00085  A0B8 20 F1        BRA   $A0AB       ;until got top
00086  A0BA 9F 74        STX   <$74        ;max memory in system
00087  A0BC 9F 27        STX   <$27        ;HI-MEM
00088  A0BE 9F 23        STX   <$23        ;next string pointer
00089  A0C0 30 89FF38    LEAX  -$00C8,X    ;HI-MEM minus 200
00090  A0C4 9F 21        STX   <$21        ;CLEAR 200
00091  A0C6 1F 14        TFR   X,S         ;set stack pointer
00092  A0C8 BD AD19      JSR   $AD19       ;initialize BASIC
00093  A0CB 8E 4558      LDX   #$4558      ;(= "EX")
00094  A0CE BC 8000      CMPX  $8000       ;Extended BASIC in ROM?
00095  A0D1 1027 DF2D    LBEQ  $8002       ;if so, jump to it
00096  A0D5 1C AF        ANDCC #$AF        ;recognise IRQ & FIRQ
00097  A0D7 8E A146      LDX   #$A146      ;=> sign on message
00098  A0DA BD B99C      JSR   $B99C       ;print sign on
00099  A0DD 8E A0E8      LDX   #$A0E8      ;=> reset vector
00100  A0E0 9F 72        STX   <$72        ;into RAM
00101  A0E2 86 55        LDA   #$55        ;BASIC startup flag
00102  A0E4 97 71        STA   <$71        ;indicate startup done
00103  A0E6 20 0B        BRA   $A0F3       ;go to OK prompt

00104  A0E8 12           NOP               ;RESET vectors here
00105  A0E9 0F 6F        CLR   <$6F        ;set keyboard input
00106  A0EB BD AD33      JSR   $AD33       ;reset BASIC stack
00107  A0EE 1C AF        ANDCC #$AF        ;mask IRQ's on
00108  A0F0 BD A928      JSR   $A928       ;CLS
00109  A0F3 7E AC73      JMP   $AC73       ;go to OK prompt
00110  A0F6 7D FF23      TST   $FF23       ;Cartridge Interrupt?
00111  A0F9 2B 01        BMI   $A0FC       ;-> If yes, jump to A0FC.
00112  A0FB 3B           RTI               ;Otherwise ignore it.
```

```
00168  A163 44           LSRA              ;D
00169  A164 59           ROLB              ;Y
00170  A165 00 4D        NEG   <$4D        ; M
00171  A167 49           ROLA              ;I
00172  A168 43           COMA              ;C
00173  A169 52                             ;R
00174  A16A 4F           CLRA              ;O
00175  A16B 53           COMB              ;S
00176  A16C 4F                             ;O
00177  A16D 46           RORA              ;F
00178  A16E 54           LSRB              ;T
00179  A16F 0D 00        TST   <0          ;(c/r)
00180  A171 8D 03        BSR   $A176       ;Get input chr
00181  A173 84 7F        ANDA  #$7F        ;Mask off bit 7
00182  A175 39           RTS
00183  A176 BD 016A      JSR   $016A       ;RAM vector
00184  A179 0F 70        CLR   <$70        ;Flag buffer unflushed
00185  A17B 0D 6F        TST   <$6F        ;Device number?
00186  A17D 27 32        BEQ   $A1B1       ;If keyboard i/p
00187  A17F 0D 79        TST   <$79        ;Number of bytes in cass. block
00188  A181 26 03        BNE   A186        ;If more to come
00189  A183 03 70        COM   <$70        ;Flag buffer empty
00190  A185 39           RTS               ;End of cassette i/p
00191  A186 34 74        PSHS  B,X,Y,U
00192  A188 9E 7A        LDX   <$7A        ;=> I/O buffer
00193  A18A A6 80        LDA   ,X+         ;Get chr from buffer
00194  A18C 34 02        PSHS  A           ;Save it
00195  A18E 9F 7A        STX   <$7A        ;Restore buffer pointer
00196  A190 0A 79        DEC   <$79        ;1 less byte in block
00197  A192 26 03        BNE   $A197       ;If more left
00198  A194 BD A635      JSR   $A635       ;Read tape block to RAM
00199  A197 35 F6        PULS  A,B,X,Y,U,PC

Flash cursor
00200  A199 0A 94        DEC   <$94        ;Flash countdown
00201  A19B 26 0E        BNE   $A1AB       ;Not time to flash
00202  A19D C6 0B        LDB   #$0B        ;Re-initialize...
00203  A19F D7 94        STB   <$94        ;Flash countdown
00204  A1A1 9E 88        LDX   <$88        ;Cursor
00205  A1A3 A6 84        LDA   ,X          ;Cursor character
00206  A1A5 8B 10        ADDA  #$10        ;Increment color
00207  A1A7 8A 8F        ORA   #$8F        ;Make block character
00208  A1A9 A7 84        STA   ,X          ;Back to screen
00209  A1AB 8E 045E      LDX   #$045E      ;Delay timeout
00210  A1AE 7E A7D3      JMP   $A7D3       ;Do delay & return

Get keyboard character & flash cursor
00211  A1B1 34 14        PSHS  B,X
00212  A1B3 8D E4        BSR   $A199       ;Flash cursor
00213  A1B5 8D 0A        BSR   $A1C1       ;Strobe keyboard
00214  A1B7 27 FA        BEQ   $A1B3       ;Go again if no key
00215  A1B9 C6 60        LDB   #$60        ;Set cursor...
00216  A1BB E7 9F0088    STB   (0088)      ;...to next position
00217  A1BF 35 94        PULS  B,X,PC

Strobe keyboard - flag result
00218  A1C1 34 14        PSHS  B,X
00219  A1C3 8D 03        BSR   $A1C8       ;Strobe keyboard
00220  A1C5 4D           TSTA              ;Set flags
00221  A1C6 35 94        PULS  B,X,PC
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Listing continued from page 58

Listing continued from page 57

```
Strobe keyboard & decode key pressed
00222  A1C8 32 7D        LEAS  -3,S      ;Get space on stack
00223  A1CA 8E 0152      LDX   #$0152    ;=> rollover bits
00224  A1CD 6F 60        CLR   0,S       ;Initialize column=0
00225  A1CF C6 FE        LDB   #$FE      ;Initialize row=1
00226  A1D1 F7 FF02      STB   $FF02     ;Setup row mask
00227  A1D4 8D 62        BSR   $A238     ;Scan kbd bit
00228  A1D6 A7 61        STA   1,S       ;Save it
00229  A1D8 A8 84        EORA  ,X        ;Mask out...
00230  A1DA A4 84        ANDA  ,X        ;...for rollover
00231  A1DC E6 61        LDB   1,S       ;Kybd bit
00232  A1DE E7 80        STB   ,X+       ;to rollover, bump rlovr pointer
00233  A1E0 4D           TSTA            ;New key?
00234  A1E1 26 0A        BNE   $A1ED     ;If so, decode character
00235  A1E3 6C 60        INC   0,S       ;Bump column count.
00236  A1E5 53           COMB            ;Set carry.
00237  A1E6 79 FF02      ROL   $FF02     ;Strobe next row.
00238  A1E9 25 E9        BLO   $A1D4     ;Another row.
00239  A1EB 35 94        PULS  B,X,PC    ;No character.


Decode Character from Keyboard
00240  A1ED F6 FF02      LDB   $FF02
00241  A1F0 E7 62        STB   2,S       ;Save kybd col. for bounce check
00242  A1F2 C6 F8        LDB   #$F8      ;Initialize = -8.
00243  A1F4 CB 08        ADDB  #8        ;Row * 8.
00244  A1F6 44           LSRA
00245  A1F7 24 FB        BHS   $A1F4
00246  A1F9 EB 60        ADDB  0,S       ;Add column.
00247  A1FB 27 48        BEQ   $A245
00248  A1FD C1 1A        CMPB  #$1A
00249  A1FF 22 46        BHI   $A247     ;If character>Z, jump to A247.
00250  A201 CA 40        ORB   #$40      ;Make ASCII A-Z.
00251  A203 8D 28        BSR   $A22D     ;Check shift.
00252  A205 27 07        BEQ   $A20E     ;Shift not pressed.
00253  A207 B6 011A      LDA   $011A     ;lowercase switch.
00254  A20A 26 02        BNE   $A20E     ;If uppercase, jmp to A20E.
00255  A20C CA 20        ORB   #$20      ;Else convert to lower.
00256  A20E E7 60        STB   0,S       ;Character to stack.
00257  A210 BE 011B      LDX   $011B     ;=> Keyboard delay DEBOUNCE
00258  A213 BD A7D3      JSR   $A7D3     ;Debounce delay.
00259  A216 E6 62        LDB   2,S       ;Check same column.
00260  A218 F7 FF02      STB   $FF02
00261  A21B 8D 1B        BSR   $A238     ;Strobe again.
00262  A21D A1 61        CMPA  1,S       ;Is it the same character?
00263  A21F 35 02        PULS  A         ;Get character from stack.
00264  A221 26 07        BNE   $A22A     ;No, ignore it.
00265  A223 81 12        CMPA  #$12      ;Shift 0?
00266  A225 26 04        BNE   $A22B     ;Jump to A22B if not.
00267  A227 73 011A      COM   $011A     ;Else tggle lowercase swtch.
00268  A22A 4F           CLRA            ;Return no character.
00269  A22B 35 90        PULS  X,PC      ;Align stack and return.


Check shift.
00270  A22D 86 7F        LDA   #$7F      ;"Shift" column.
00271  A22F B7 FF02      STA   $FF02
00272  A232 B6 FF00      LDA   $FF00     ;Check keyboard row.
00273  A235 84 40        ANDA  #$40      ;Extract shift.
00274  A237 39           RTS
```

```
00330  A2A0 A7 80        STA   ,X+       ;Save chr, increment buffer.
00331  A2A2 9F 7A        STX   <$7A      ;Save buffer pointer.
00332  A2A4 0C 79        INC   <$79      ;Bump number of bytes in block.
00333  A2A6 35 96        PULS  A,B,X,PC

Set Pointers, Do cassette Output.
00334  A2A8 C6 01        LDB   #1        ;Data type.
00335  A2AA D7 7C        STB   <$7C      ;Setup Block Type.
00336  A2AC 8E 01DA      LDX   #$01DA    ;=> output buffer.
00337  A2AF 9F 7E        STX   <$7E
00338  A2B1 D6 79        LDB   <$79      ;Number of bytes.
00339  A2B3 D7 7D        STB   <$7D
00340  A2B5 34 62        PSHS  A,Y,U
00341  A2B7 BD A7E5      JSR   $A7E5     ;Do complete tape output.
00342  A2BA 35 62        PULS  A,Y,U
00343  A2BC 7E A650      JMP   $A650     ;Reset # bytes & I/O pointr.

RS-232 Byte Output
00344  A2BF 34 17        PSHS  CCR,A,B,X
00345  A2C1 1A 50        ORCC  #$50      ;Disable Interrupts.
00346  A2C3 8D 36        BSR   $A2FB     ;Start Pulse.
00347  A2C5 48           ASLA            ;Chop bit 7
00348  A2C6 C6 08        LDB   #8        ;Bit count.
00349  A2C8 34 04        PSHS  B         ;Save the count.
00350  A2CA 5F           CLRB
00351  A2CB 44           LSRA            ;Bit 0 to CF
00352  A2CC 59           ROLB            ;Into...
00353  A2CD 59           ROLB            ;...bit 1
00354  A2CE F7 FF20      STB   $FF20     ;To port.
00355  A2D1 8D 2F        BSR   $A302     ;baud delay.
00356  A2D3 12           NOP             ;  "
00357  A2D4 12           NOP             ;  "
00358  A2D5 12           NOP             ;  "
00359  A2D6 8D 2A        BSR   $A302     ;---
00360  A2D8 35 04        PULS  B         ;Get count.
00361  A2DA 5A           DECB            ;Are all 8 done?
00362  A2DB 26 EB        BNE   $A2C8     ;Continue if not.
00363  A2DD 8D 1C        BSR   $A2FB     ;Stop bit.
00364  A2DF 35 03        PULS  CCR,A     ;Restore character output.
00365  A2E1 81 0D        CMPA  #$0D      ;Was it a carriage return?
00366  A2E3 27 08        BEQ   A2ED      ;Yes, do delay.
00367  A2E5 0C 9C        INC   <$9C      ;Bump line character count.
00368  A2E7 D6 9C        LDB   <$9C      ;Is this the end of the line?
00369  A2E9 D1 9B        CMPB  <$9B
00370  A2EB 25 06        BLO   A2F3      ;No, it isn't.
00371  A2ED 0F 9C        CLR   <$9C      ;Reset Line character count.
00372  A2EF 8D 14        BSR   $A305     ;Line delay.
00373  A2F1 8D 12        BSR   $A305
00374  A2F3 F6 FF22      LDB   $FF22     ;Wait 4 hndshake frm data Input!
00375  A2F6 54           LSRB            ;Got it yet?
00376  A2F7 25 FA        BLO   A2F3      ;Keep waiting if not.
00377  A2F9 35 94        PULS  B,X,PC

Output bit to RS-232
00378  A2FB C6 02        LDB   #2        ;RS232 Pulse Output.
00379  A2FD F7 FF20      STB   $FF20
00380  A300 8D 10        BSR   A302      ;Delay * two
00381  A302 9E 95        LDX   <$95      ;600 Baud delay.
00382  A304 8C 9E97      CMPX  #$9E97    ;(LDX <$97)
00383  A307 7E A7D3      JMP   $A7D3     ;delay
```

```
Strobe keyboard.
00275  A238 B6 FF00      LDA   $FF00     ;Keyboard row.
00276  A23B 8A 80        ORA   #$80      ;Ignore joystck cmprsn.
00277  A23D 7D FF02      TST   $FF02     ;Keyboard column.
00278  A240 2B 02        BMI   $A244
00279  A242 8A C0        ORA   #$C0
00280  A244 39           RTS
00281  A245 C6 33        LDB   #$33      ;=@ if column=0, and row=0
00282  A247 8E A238      LDX   #$A238    ;Offset for keyboard table.
00283  A24A C1 21        CMPB  #$21      ;Chr <"A"?
00284  A24C 25 16        BLO   $A264     ;If so
00285  A24E 8E A21A      LDX   #$A21A    ;Offset for keyboard table.
00286  A251 C1 30        CMPB  #$30      ;Chr >="0"?
00287  A253 24 0F        BHS   $A264     ;If so
00288  A255 8D D6        BSR   $A22D     ;Scan for shift.
00289  A257 C1 2B        CMPB  #$2B
00290  A259 23 02        BLS   $A25D
00291  A25B 88 40        EORA  #$40      ;Reverse shift status.
00292  A25D 4D           TSTA            ;Is it shifted?
00293  A25E 27 AE        BEQ   $A20E     ;Return char if no shift.
00294  A260 CB 10        ADDB  #$10
00295  A262 20 AA        BRA   $A20E     ;Return character.
00296  A264 58           ASLB            ;Get table offset.
00297  A265 8D C6        BSR   $A22D     ;Scan shift.
00298  A267 26 01        BNE   $A26A     ;->If no shift, jmp to A26A.
00299  A269 5C           INCB            ;Else bump table offset.
00300  A26A E6 85        LDB   B,X       ;Get character from table.
00301  A26C 20 A0        BRA   $A20E     ;Return character.

KEYBOARD TABLE
00302  A26E 5E                           ;up-arrow
00303  A26F 5F           CLRB            ;shift up-arrow
00304  A270 0A 5B        DEC   <$5B      ;dn-arrow & shift dn-arrow
00305  A272 08 15        ASL   <$15      ;left-arrow
00306  A274 09 5D        ROL   <$5D      ;right-arrow
00307  A276 20 20        BRA   $A298
00308  A278 30 12        LEAX  -$0E,X    ;zero & shift zero
00309  A27A 0D 0D        TST   <$0D      ;carriage retn & shift carr. rtn
00310  A27C 0C 5C        INC   <$5C      ;CLEAR & backslash
00311  A27E 03 03        COM   <3        ;BREAK & shift BREAK
00312  A280 40           NEGA            ;"@"
00313  A281 13           SYNC            ;shift "@"

Print Character as per Device Number.
00314  A282 BD 0167      JSR   $0167     ;RAM vector
00315  A285 34 04        PSHS  B         ;
00316  A287 D6 6F        LDB   <$6F      ;Get device number.
00317  A289 5C           INCB
00318  A28A 35 04        PULS  B
00319  A28C 2B 31        BMI   $A2BF     ;RS-232 LPRINT
00320  A28E 26 7A        BNE   $A30A     ;PRINT to video
00321  A290 34 16        PSHS  A,B,X
00322  A292 D6 78        LDB   <$78      ;I/O mode.
00323  A294 5A           DECB            ; Input or Output?
00324  A295 27 0F        BEQ   $A2A6     ;If Input, return.
00325  A297 D6 79        LDB   <$79      ;Number of bytes in buffer.
00326  A299 5C           INCB            ; Does it equal 255?
00327  A29A 26 02        BNE   $A29E     ;Jump to A29E if not.
00328  A29C 8D 0A        BSR   $A2A8     ;Set Pointers, do cass Output.
00329  A29E 9E 7A        LDX   <$7A      ;I/O buffer.

PRINT TO VIDEO
00384  A30A 34 16        PSHS  A,B,X
00385  A30C 9E 88        LDX   <$88      ;Cursor position.
00386  A30E 81 08        CMPA  #8        ;Backspace?
00387  A310 26 0B        BNE   $A31D     ;If not.
00388  A312 8C 0400      CMPX  #$0400    ;Are we already at top LHS?
00389  A315 27 46        BEQ   $A35D     ;Yes, ignore.
00390  A317 86 60        LDA   #$60      ;Space
00391  A319 A7 82        STA   ,-X       ;Back off cursor.
00392  A31B 20 27        BRA   $A344     ;Save new position.
00393  A31D 81 0D        CMPA  #$0D      ;Carriage return?
00394  A31F 26 0E        BNE   $A32F     ;If not.
00395  A321 9E 88        LDX   <$88      ;Cursor position.
00396  A323 86 60        LDA   #$60      ;Space to cursor.
00397  A325 A7 80        STA   ,X+
00398  A327 1F 10        TFR   X,D       ;End of line?
00399  A329 C5 1F        BITB  #$1F
00400  A32B 26 F6        BNE   $A323     ;No, continue.
00401  A32D 20 15        BRA   $A344     ;Save new cursor
00402  A32F 81 20        CMPA  #$20
00403  A331 25 2A        BLO   $A35D     ;Ignore if other control
00404  A333 4D           TSTA
00405  A334 2B 0C        BMI   $A342     ;Graphic
00406  A336 81 40        CMPA  #$40      ;" " to "9"?
00407  A338 25 06        BLO   A340      ;jump to A340 if so
00408  A33A 81 60        CMPA  #$60      ;Uppercase?
00409  A33C 25 04        BLO   A342      ;jump to A342 if so
00410  A33E 84 DF        ANDA  #$DF      ;leave out offset
00411  A340 88 40        EORA  #$40      ;Add offset if necessary
00412  A342 A7 80        STA   ,X+       ;Send character to screen
00413  A344 9F 88        STX   <$88      ;new cursor position
00414  A346 8C 05FF      CMPX  #$05FF    ;End of screen
00415  A349 23 12        BLS   $A35D     ;jump to A35D if not
00416  A34B 8E 0400      LDX   #$0400    ;SCROLL
00417  A34E EC 8820      LDD   $20,X
00418  A351 ED 81        STD   ,X++
00419  A353 8C 05E0      CMPX  #$05E0
00420  A356 25 F6        BLO   $A34E
00421  A358 C6 60        LDB   #$60      ;Clear to end of line
00422  A35A BD A92D      JSR   $A92D
00423  A35D 35 96        PULS  A,B,X,PC
Initialize Output Parameters, as per Output device.
00424  A35F BD 0164      JSR   $0164     ;RAM vector.
00425  A362 34 16        PSHS  A,B,X
00426  A364 0F 6E        CLR   <$6E      ;Initialize "Print" device.
00427  A366 96 6F        LDA   <$6F      ;Output mode
00428  A368 27 09        BEQ   A373      ;Jump to A373 if video.
00429  A36A 4C           INCA            ;-1?
00430  A36B 27 17        BEQ   $A384     ;Jump to A384 if cassette.
00431  A36D 9E 99        LDX   <$99      ;LPRINT Parameters
00432  A36F DC 9B        LDD   <$9B
00433  A371 20 09        BRA   A37C
00434  A373 D6 89        LDB   <$89      ;LSB cursor location
00435  A375 C4 1F        ANDB  #$1F      ;Position in line, modulo 32
00436  A377 8E 1010      LDX   #$1010    ;16 chr "," col & 16 chr max.tab
00437  A37A 86 20        LDA   #$20      ;32 characters/output line
00438  A37C 9F 6A        STX   <$6A      ;"," col. width, max tab postion
00439  A37E D7 6C        STB   <$6C      ;set line position
00440  A380 97 6D        STA   <$6D      ;number chars. per output line
```

Listing continued from page 59

```
00441  A382 35 96        PULS  A,B,X,PC

Set Cassette Output Parameters
00442  A384 03 6E        COM   <$6E      ;Output Device #=-1
00443  A386 8E 0100      LDX   #$0100    ;Comma col. width, max. tab pos.
00444  A389 4F           CLRA            ;Line position
00445  A38A 5F           CLRB            ;characters per output line
00446  A38B 20 EF        BRA   $A37C

Input Characters to buffer
00447  A38D BD A928      JSR   $A928     ;-> jump to CLS
00448  A390 BD 0182      JSR   $0182     ;- jump to RAM Vector
00449  A393 0F 87        CLR   <$87      ;clear INKEY character
00450  A395 8E 02DD      LDX   #$02DD    ;=> Keyboard Input/Output buffer
00451  A398 C6 01        LDB   #1        ;initialize character count
00452  A39A BD A171      JSR   $A171     ;-> Get keyboard character
00453  A39D 0D 70        TST   <$70      ;Input/Output buffer flushed?
00454  A39F 26 2B        BNE   $A3CC
00455  A3A1 0D 6F        TST   <$6F      ;Is the device type = keyboard?
00456  A3A3 26 23        BNE   $A3C8     ;-> jmp to A3C8 if not Kybrd I/O
00457  A3A5 81 0C        CMPA  #$0C      ;Is it the CLEAR key?
00458  A3A7 27 E4        BEQ   $A38D     ;->Yes, jmp to CLS & start again
00459  A3A9 81 08        CMPA  #8        ;Is it the BACKSPACE key?
00460  A3AB 26 07        BNE   $A3B4     ;-> Jump to A3B4 if it isn't
00461  A3AD 5A           DECB            ;decrement character count
00462  A3AE 27 E0        BEQ   $A390     ;-jmp to A390 & strt agn if done
00463  A3B0 30 1F        LEAX  -1,X      ;Backoff Buffer
00464  A3B2 20 34        BRA   $A3E8     ;-Jump to A3E8 & Print a BCKSPCE
00465  A3B4 81 15        CMPA  #$15      ;Is it a SHIFT BACKSPACE?
00466  A3B6 26 0A        BNE   $A3C2     ;jump to A3C2 if it isn't
00467  A3B8 5A           DECB            ;Character count -1
00468  A3B9 27 D5        BEQ   $A390     ;-jmp to A390 & strt agn if done
00469  A3BB 86 08        LDA   #8        ;Print a backspace
00470  A3BD BD A282      JSR   $A282
00471  A3C0 20 F6        BRA   $A3B8     ;Repeat until buffer is empty
00472  A3C2 81 03        CMPA  #3        ;Is it the BREAK key?
00473  A3C4 1A 01        ORCC  #1        ;set carry flag just in case
00474  A3C6 27 05        BEQ   A3CD      ;- Jump to A3CD if it is BREAK
00475  A3C8 81 0D        CMPA  #$0D      ;Is it the Enter Key?
00476  A3CA 26 0D        BNE   $A3D9     ;
00477  A3CC 4F           CLRA            ;End no CF
00478  A3CD 34 01        PSHS  CCR       ;save flags
00479  A3CF BD B958      JSR   $B958     ;- Print Carriage Return
00480  A3D2 6F 84        CLR   ,X        ;Delimit Buffer
00481  A3D4 8E 02DC      LDX   #$02DC
00482  A3D7 35 81        PULS  CCR,PC    ;-> Return,(CF=BREAK, B=# of
                                         ;      characters)
                                         ;
00483  A3D9 81 20        CMPA  #$20      ;Is it a control character?
00484  A3DB 25 BD        BLO   $A39A     ;- If yes, ignore & jump to A39A
00485  A3DD 81 7B        CMPA  #$7B      ;Is it greater than Z?
00486  A3DF 24 B9        BHS   $A39A     ;- If yes, ignore & jump to A39A
00487  A3E1 C1 FA        CMPB  #$FA      ;Is it grtr than 249 characters?
00488  A3E3 24 B5        BHS   $A39A     ;-> If yes, ignore & Jmp to A39A
00489  A3E5 A7 80        STA   ,X+       ;Otherwise, load it into buffer
00490  A3E7 5C           INCB            ;Bump the character count
00491  A3E8 BD A282      JSR   $A282     ;Jmp to A282 & print character
00492  A3EB 20 AD        BRA   $A39A

Check File Open for Input/Output
00493  A3ED BD 016D      JSR   $016D     ;-> RAM
00494  A3F0 96 6F        LDA   <$6F      ;Device number
00495  A3F2 27 21        BEQ   $A415     ;-> RTS if normal
00496  A3F4 4C           INCA            ;must be = -1
00497  A3F5 26 0C        BNE   $A403     ;- If not, jump to A403,
                                            (File Mode Error)
00498  A3F7 96 78        LDA   <$78      ;File number
00499  A3F9 26 05        BNE   $A400     ;->If file is open, jump to A400
00500  A3FB C6 2C        LDB   #$2C      ;- NO Error
00501  A3FD 7E AC46      JMP   $AC46
00502  A400 4A           DECA            ;must be  #1
00503  A401 27 12        BEQ   $A415     ;-> RTS if OK
00504  A403 7E A616      JMP   $A616     ;->Jmp to A616 (File Mode Error)

Check File Open for OUTPUT
00505  A406 BD 0170      JSR   $0170     ;-> RAM vector
00506  A409 96 6F        LDA   <$6F      ;Device Number
00507  A40B 4C           INCA            ;Is it equal to -1?
00508  A40C 26 07        BNE   $A415     ;-> If not tape, jump to A415
00509  A40E 96 78        LDA   <$78      ;File Mode
00510  A410 27 E9        BEQ   $A3FB     ;NO Error if zero
00511  A412 4A           DECA            ;Is it Input?
00512  A413 27 EE        BEQ   $A403     ;->If file open for input,
                                         ; jump to A403 (File Mode Error)
00513  A415 39           RTS
CLOSE n
00514  A416 27 0E        BEQ   $A426     ;-> Close (cr)
00515  A418 BD A5A5      JSR   $A5A5     ;-> Get Device number
00516  A41B 8D 10        BSR   $A42D     ;Do close
00517  A41D 9D A5        JSR   <$A5      ;Parse current chr
00518  A41F 27 2A        BEQ   $A44B     ;-> RTS if End of Line
00519  A421 BD A5A2      JSR   $A5A2     ;Else get next device #
00520  A424 20 F5        BRA   $A41B     ;And close that one

CLOSE
00521  A426 BD 0173      JSR   $0173     ;-> RAM
00522  A429 86 FF        LDA   #$FF      ;Output Device = cassette
00523   A42B 97 6F       STA   <$6F
00524  A42D BD 0176      JSR   $0176     ;-> RAM
00525  A430 96 6F        LDA   <$6F      ;- Device number
00526  A432 0F 6F        CLR   <$6F      ;- Zero the device number
00527  A434 4C           INCA
00528  A435 26 14        BNE   $A44B     ;->If not cass,jmp to A44B (RTS)
00529  A437 96 78        LDA   <$78      ;Was it an output file?
00530  A439 81 02        CMPA  #2
00531  A43B 26 0C        BNE   $A449     ;-> If not, jump to A449
FLUSH cassette Output Buffer
00532  A43D 96 79        LDA   <$79      ;Number of bytes to Output
00533  A43F 27 08        BEQ   $A449     ;- if zero, jump to A449
00534  A441 BD A2A8      JSR   $A2A8     ;-> Do pointers & output
00535  A444 C6 FF        LDB   #$FF      ;last block indicator
00536  A446 BD A2AA      JSR   $A2AA     ;-> Do output of end block
00537  A449 0F 78        CLR   <$78      ;CLEAR input/output indicator
00538  A44B 39           RTS
```

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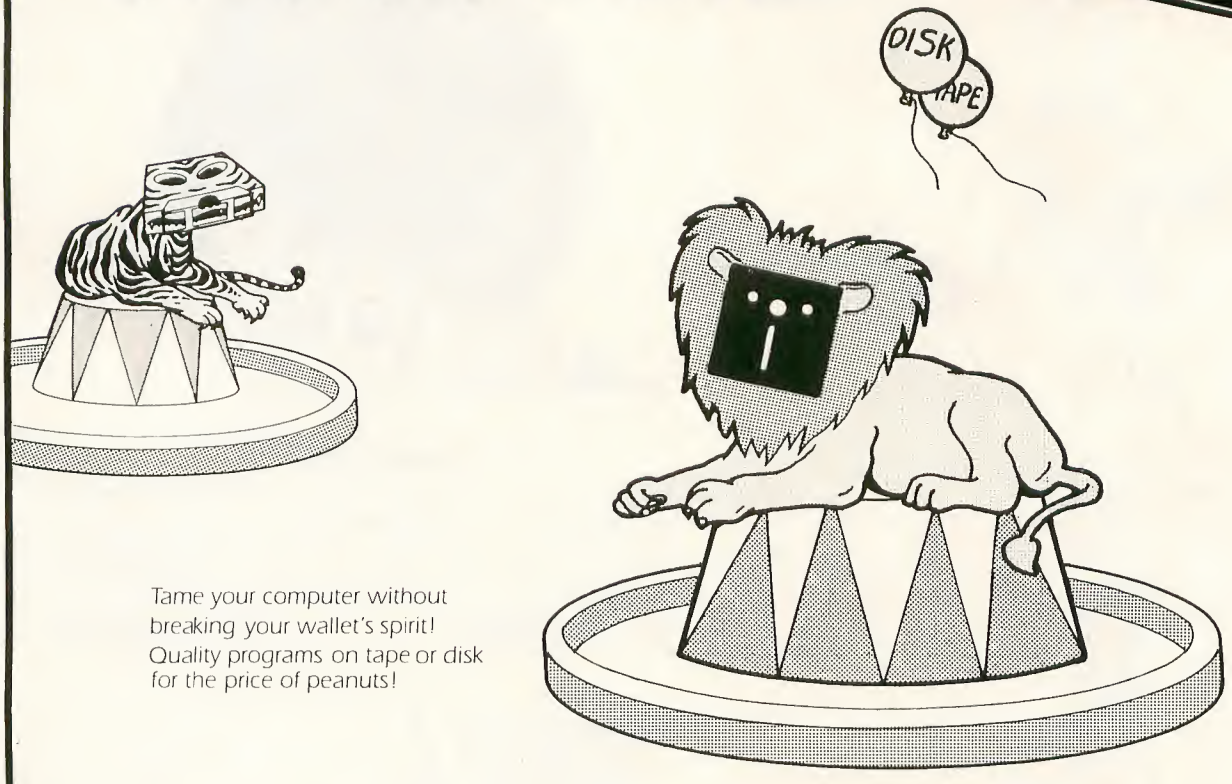

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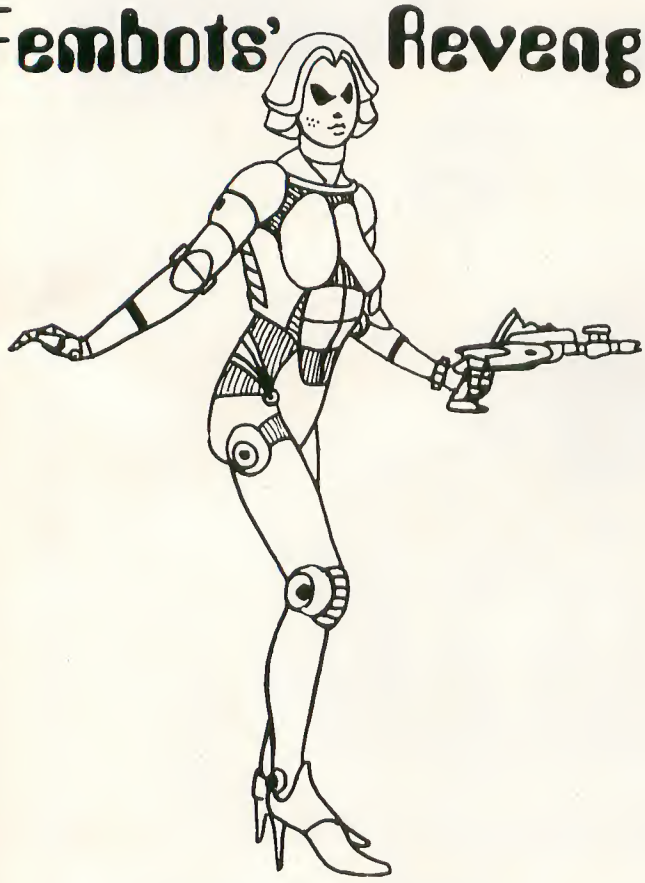

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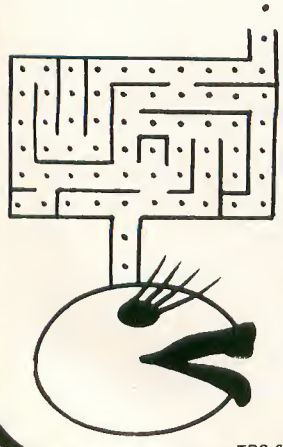

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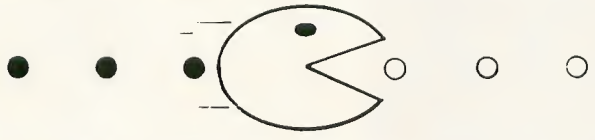

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What is Color Disk Basic?

A command summary for the disk curious.

by Franklyn D. Miller

I RECENTLY ACQUIRED Color Disk Basic and am rather impressed with it. I thought the readers of **The Color Computer Magazine** might be interested in learning how it compares with Model I DOS.

The disk drive is larger and quieter than Model I drives, and the transformer is enclosed. The 8K ROMpak plugs into the right side of the computer and attaches to the drive with the cable supplied, which provides for two drives.

The disk system is entirely in Basic; there is no separate DOS as Model I and Model II users are accustomed to. Color Basic and Extended Color Basic are always available with the plug-in ROMpak in place. Although the system operates with the 16K RAM memory, 32K is highly desirable. The disk system uses 2K for itself, leaving 6,439 bytes for the user when in the graphics mode. A total of 37 error signals are available, but only as two letter messages, reminiscent of Level II Basic. The disks are double density and can contain a total of 161,280 bytes. A granule contains 2,304 bytes with 68 granules and 35 tracks on a disk. I won't go into details about disk data organization, since the operating manual devotes six pages to the subject.

The manual (92 pages) is well written and contains 11 chapters and eight appendices, one of which is a memory map. Eight useful sample programs illustrate the use of a disk system. Thirty-six new commands are available, some of which are not available with Model I DOS. Each chapter has a group of questions with the answers in an appendix. There are also 10 programming exercises in another appendix.

Once again, Microsoft has done an outstanding job of packing a lot of useful code into a small amount of memory. In what follows I will assume the reader is familiar with Model I Radio Shack DOS. I will refer to DOS and Disk Basic merely as one operating system under the name "DOS."

Basic Commands and Comments

BACKUP

- Essentially the same as DOS.

CVN

- Converts a coded string back to a number but with nine-figure precision. Similar to CVS in DOS.

DIR

• This command lists the directory on the screen but has a serious drawback in that it displays the complete directory. It is very tricky to position the screen to the portion of interest using the shift and @ keys. The format is considerably different from DOS. Here is an example:

```
OURPROG   BAS   0  B  3
```

From left to right are displayed file name, extension, type of storage, code, and number of granules.

That deserves a little explanation. The type of storage is a number from 0 to 3 with the following meanings:

0 = Basic program
1 = Basic data file
2 = Machine language
3 = Editor source file

Code is either A or B for ASCII or binary format.

DRIVE

• Normally the default is drive zero when a drive is not specified. The DRIVE command allows you to set the default to any drive from 0 to 3. This is useful if you have more than one drive.

DSKINI x

• Equivalent to FORMAT in DOS except that X = drive number. The disk is formatted and verified, and the computer returns to the Command mode at completion. It does not require user interaction.

DSKI$

• A versatile command not available in DOS. With this command you can read any sector on any track into strings of 128 bytes. The format is: DSKI$ drive number, track number, sector number, string variable1, string variable2

DSKO$

• This is the complement of DSKI$. It puts strings of up to 128 bytes on the disk, two strings per sector.

EOF

• Same as DOS.

FIELD

• Same as DOS, but see FILES.

FILES

• The computer automatically uses two buffers (not three), at power-up. FILES gives you considerable flexibility. The format is: FILES X, Y, where X = the number of buffers, Y = the size of the buffers.

The buffers can be any size consistent within the memory limits and can be set either in the Command mode or in a program. It is not necessary to turn the computer off to reset files and file size.

LOADM

• This command loads a machine language program from disk. Because of the instruction set for the 6809E, most machine language programs are relocatable. The 6809E can branch to a relative address anywhere in memory. The format is: LOADM "Filename", x where x is an offset in decimal.

This is very useful for machine language programmers.

LOC

• LOC returns the current record number of the buffer that is open. Very nice for random access filing (which Disk Color calls direct access).

MKN$

• This converts a number to a five-byte coded string with nine significant digits. Similar to MKS$.

OPEN

• Opens a buffer. There are three modes that can be used:

I – Sequential input
O – Sequential output
D – Input or output to a random file (direct access).

You can also specify the record length and are not restricted to 256 bytes. The default is 256 bytes. Note that being able to specify a buffer size and record length means less wasted disk space, and possibly, more records.

PRINT #, Using

• Use this to specify the format of the information placed on a disk. All the parameters available with USING can be used.

PUT #

• Same as DOS except that if you do not use a record number, the current record will be used.

RENAME

• Same as DOS but available in Basic.

RUN

• The format is :RUN "Filename", R. If you use the R option, all current files will remain open.

SAVEM

• This is not available directly in DOS. The format is: SAVEM "Filename:x", beginning address, ending address, entry address. The command saves a machine language program which can be recovered with LOAD M.

UNLOAD X

• X is a drive number. The command closes all open files in the drive number specified.

VERIFY

• Same as DOS but available at any time from Basic. It can be turned off or on. Saving takes about twice as long with VERIFY ON.

WRITE #

• This is similar to PRINT # but you can only use commas. Hence, more disk space is required. Another difference between Disk Color and DOS is in the use of file name extensions. If one is not specified, the computer will supply one by default. The three supplied are :BAS if the program is a Basic program; DAT if the file is a data file; BIN if it is a machine language program. When a program is Loaded, the proper extension must be used or an NE (no entry) error will occur.

Table 1

/0	Division by zero
AE	Existing File
AO	Attempted to Open an already open file
BR	Bad record number
BS	Bad subscript (subscript out of range)
CN	Can't continue
DD	Attempt to redimension an array
DF	Disk full
DN	Device or drive number error
DS	Direct statement in file
ER	Past end of record
FC	Illegal function call
FD	Bad file data
FM	Bad file mode
FN	Bad file name
FD	Field overflow
FS	Bad file structure
ID	Illegal direct statement
IE	Input past end of file
IO	Input/output error
LS	Long string
NE	No entry found
NF	Next without for
NO	File not open
OB	Out of buffer space
OD	Out of data
OM	Out of memory
OS	Out of string space
OV	Overflow. Number too large
RG	Return without a GOSUB
SE	Tried to SET a string that was not FIELDed
SN	Syntax error
ST	String formula too complex
TM	Type mismatch
UL	Undefined line
VF	Verification error
WP	Disk write protected

Table 2 contains a list of the Basic "tokens" corresponding to the new commands in Color Disk Basic.

Summary

All in all, this is a good operating system with a well written manual (but not for the novice), and it seems reliable. It does not provide for program recovery, but since the system is in ROM, it is not likely to be required. Double density disks are certainly desirable for data storage, but disk space can be wasted when storing shorter programs. The ability to change record size at will is definitely a strong plus. The complete system, Color Basic, Extended Color Basic, and Color Disk Basic supply almost everything available on the Model I with more besides.

The main things lacking are DEFINT, control keys, ERL, ON ERROR GOTO, ERR/2 ; 1, FRE, AUTO, CLOAD ?, and so on. But then, nothing is perfect.

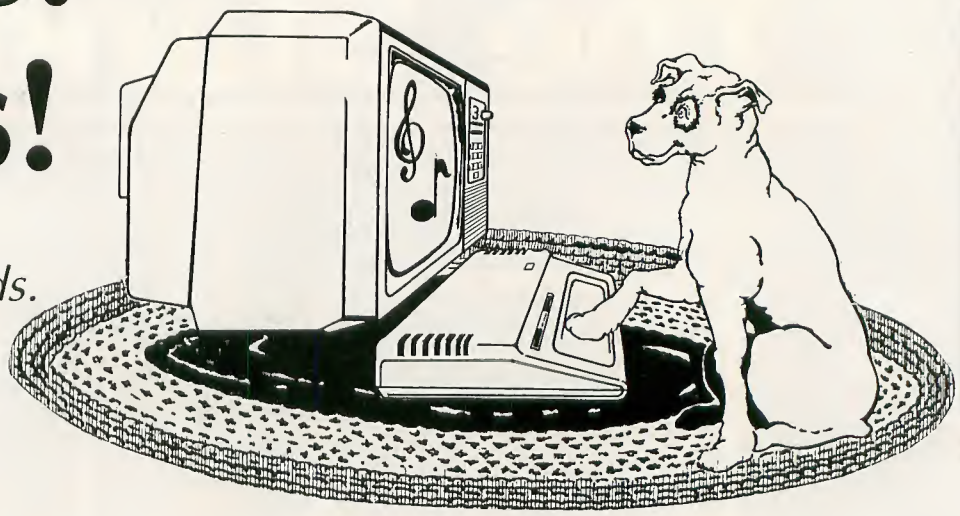
A total of 141 commands and instructions are available, of which 35 to 40 are not available on the Model I (depending upon how you count). ■■■

Table 2

	1st Byte	2nd Byte		1st Byte	2nd Byte		1st Byte	2nd Byte
BACKUP	221		FREE	255		OPEN	153	
CLOSE	154		GET	196		PRINT	135	
COPY	222		INPUT	137		PUT	197	
CVN	255	162	KILL	210		RENAME	214	
DIR	206		LINE INPUT	187	137	RESET	215	
DRIVE	207		LOAD	211		RUN	142	
DSKINI	220		LOADM	211	77	SAVE	216	
DSKI$	223		LOC	255	164	SAVEM	216	
DSKO$	224		LOF	255		UNLOAD	219	
EOF	255	140	LSET	212		VERIFY ON	218	136
FIELD	208		MERGE	213		VERIFY OFF	218	170
FILES	209		MKN$	255	166	WRITE	217	

Zounds! Sounds!

Tuning up your Color Computer's vocal cords.



by William Barden Jr.

BACK IN THE DAYS of the first microcomputer, the Altair 8800, computer music was hard to come by. I have difficulty remembering exactly how it was, as it was... omigosh. . . about eight years ago. As I recall, we were content to place a radio near the computer and listen to the musical tones produced by the pulses generated by different program loops. (No kidding! This technique dates back to the 1950's, at least — it was used as a debugging technique, Jake Commander informs me, on early British machines which had a built-in speaker! But I digress...)

Things are more sophisticated today, especially on the Color Computer. We now have the capability to generate all kinds of sounds and transmit through the television speaker. The sounds are generally musical tones produced by Basic's SOUND and PLAY commands. I think you'll be surprised to find that you can generate many other sounds, ranging from the cry of a wounded programmer beating through an involved Basic program to the dulcet tones of a well-tempered (at least, fairly well-tempered) clavier.

First Movement — Largo con Hardware

If you want, you can diddle musical Basic programs using SOUND and PLAY commands. However, I want to show you what the Color Computer can do with sound. To do that, I've got to discuss

Figure 1. *Sound generation in the Color Computer.*

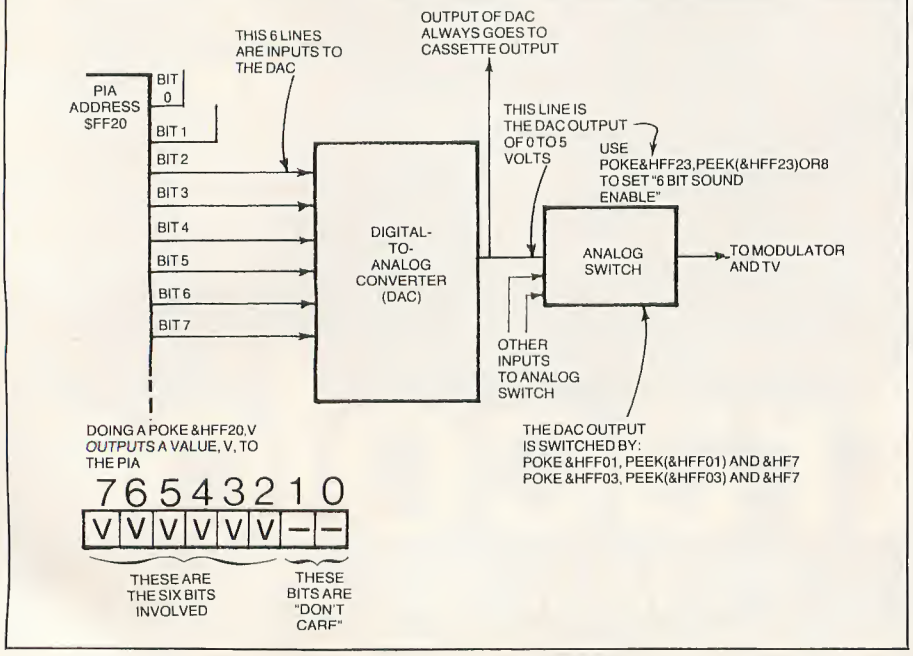
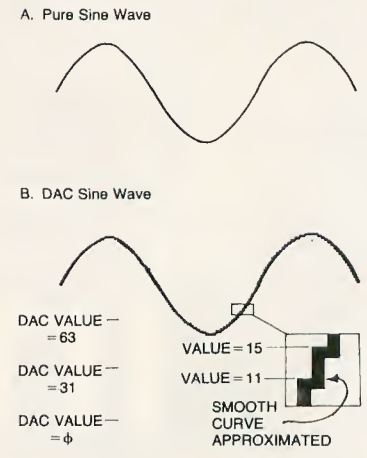


Figure 2. *Pure sine wave vs. DAC sine wave.*



hardware to a certain extent. Bear with me and I'll try to make it as painless as possible.

Look at Figure 1; the basic sound generation mechanism in the Color Computer is called a digital-to-analog converter, commonly known as a DAC. A digital value from 0 through 63 (six bits — 000000 through 111111) is first output to a PIA (peripheral interface adapter) with the address of $FF20. The six-line output from this PIA goes directly into the DAC. The DAC converts the digital value to a voltage level of about 0 to about 5 volts. This voltage level is then routed through an analog switch, and then to the television modulator that broadcasts to the television plugged into the computer. The output also goes to the cassette output jack.

All sound associated with the Color Computer, from cassette tones of 1200 and 2400 cycles per second (hertz) to sounds generated by SOUND and PLAY commands and speech generated in some Color Computer games, goes through this basic process — value to PIA, conversion to analog value by DAC, and routing to television or cassette.

Take the 2400 cycles-per-second sound for recording on cassette (from a CSAVE command) for example: a 2400 cycle-per-second tone ideally would look like Figure 2a, a "sine wave." This tone is the pure musical tone you would hear from electronic music. The Basic interpreter simulates this tone by outputting a series of digital values to the DAC from a table in ROM (locations 43100 through 43135). The result is something approaching the 2400 hertz sine wave, and looks like Figure 2b.

The cassette output uses two tones, 1200 and 2400 cycles per second, to denote binary data. At 1200 hertz it performs the same loop in ROM, except that alternate values are skipped. The routine that gets the values from the table resides in ROM and is specifically geared to that function. We can use similar logic, though, and create a short assembly-language routine that will output a table of values to produce sounds. That routine appears in Listing 1 as a Basic program with embedded assembly-language code; the actual assembly-language code is shown in Listing 2 for reference. Listing 1 will run by itself — it relocates the machine-language bytes to the memory area starting at $3F07 (16135) before execution.

Why use assembly language? Basic is simply much too slow to process data for sound generation in the Color Computer. We have to be able to output values to the DAC at rates of *at least* thousands of values per second to generate a full range of sounds, since typical sounds range from about 20 cycles per second through 20,000 cycles per second.

This Basic/assembly-language routine simply takes a table of values and outputs them to the DAC. The routine uses four variables to control the sound. The first variable, DC, is a delay count between values and can be any number from 1 through 255. The greater this value, the longer the delay between DAC outputs, and the lower in pitch will be the sound. The second variable, RC, is a repeat count that defines how many times the table values are to be repeated. Repeats of 1 through 65,535 can be used. The next variable, AD, is the address of the data for the table. This is a ROM or RAM address from 0 through 65,535. The fourth variable, N, is the number of entries in the table. This can range from 1 to 65,535.

Suppose you want to generate a sine wave sound. The location of the sine wave table for cassette operation is $AB5C (43100 decimal in ROM). If you want an approximate 300 cycles-per-second tone for about 3.5 seconds, use the values shown in Table 1. Try it.

Table 1

DC = 10	10 for delay count
RC = 1000	36 entries repeat 1000 times
TA = 43100	table starts at ROM 43100
NE = 36	36 entries in table

300 cycles per second (300 hertz) for about 3.5 seconds

Try changing the values for the delay count and then executing the Basic program. Notice how the pitch varies, dependent upon the DC variable? Try changing the repeat count (RC); short or long sound sequences can be generated by changing RC. In this case, the sine wave from the table plays for longer and longer intervals as you increase the RC variable.

Now comes the really interesting part of this program. We were using the sine wave table in ROM to generate sine waves; how about other data? *Any data in ROM or RAM can be used!* Try different AD values, and vary the DC and RC variables. You'll find a surprising variety of sounds ranging from gunshots to a voice saying *"You have voided the warranty on this machine. It will self-destruct in 10 seconds!"* I'm just kidding about that last part...

As a matter of fact, by experimenting you can discover exactly how some of those Atari game sounds are produced — by using existing random (almost) data in ROM or RAM!

Second Movement — Un Poco SOUND

Let's get back to solid ground; we've gone off on somewhat of a tangent concerning random sounds. It's fairly easy to produce random sounds just by doing an output to the DAC using random data. But what about musical sounds?

The Basic sound command in the Color Computer is called SOUND. This is somewhat of a misnomer. SOUND really produces only one sound, and it looks like Figure 3. This waveshape is a poor man's sine wave consisting of three levels (0, 31, or 63) when only the top six bits of each value are considered.

Why not use a complete sine wave, as in the case of the cassette tone? Believe

Listing 1

```
100 'BASIC/AL SOUND GENERATOR
110 CLEAR 200,&H3EFF
120 DEFUSR0=&H3F07
130 DATA &HCE,&H3F,&H00,&HAE,&H43,&H10,&HAE,&H45
140 DATA &HA6,&H80,&H87,&HFF,&H20,&HE6,&HC4,&H5A
150 DATA &H26,&HFD,&H31,&H3F,&H26,&HF2,&HAE,&H41
160 DATA &H30,&H1F,&HAF,&H41,&H26,&HE5,&H39
170 FOR I=&H3F07 TO &H3F25
180 READ A: POKE I,A
190 NEXT I
200 POKE &HFF01,PEEK(&HFF01)AND&HF7
210 POKE &HFF03,PEEK(&HFF03)AND&HF7
220 POKE &HFF23,PEEK(&HFF23)OR8
230 INPUT "DC=";DC
240 INPUT "RC=";RC
250 INPUT "TA=";TA
260 INPUT "NE=";NE
270 POKE &H3F00,DC
280 POKE &H3F01,INT(RC/256): POKE &H3F02,RC-INT(RC/256)*256
290 POKE &H3F03,INT(TA/256): POKE &H3F04,TA-INT(TA/256)*256
300 POKE &H3F05,INT(NE/256): POKE &H3F06,NE-INT(NE/256)*256
310 A=USR0(0)
320 GOTO 230
330 FOR I=&H3F07 TO &H3F25
340 PRINT HEX$(PEEK(I));" ";
350 NEXT I
```

Listing 2

```
                    00100 ******************************************
                    00110 * SOUND GENERATOR                        *
                    00120 * ENTRY: ($3F00)=DELAY COUNT            *
                    00130 *         ($3F01,2)=REPEAT COUNT         *
                    00140 *         ($3F03,4)=TABLE ADDRESS        *
                    00150 *         ($3F05,6)=# OF ENTRIES         *
                    00160 ******************************************
3F00                00170           ORG     $3F00
3F00                00180           RMB     7
3F07 CE   3F00      00190 RANDOM    LDU     #$3F00   POINT TO PARAMETERS
3F0A AE   43        00200 RAN005    LDX     +3,U       GET TABLE START
3F0C 10AE 45        00205           LDY     +5,U         GET # ENTRIES
3F0F A6   80        00210 RAN010    LDA     ,X+          GET VALUE
3F11 B7   FF20      00220           STA     $FF20        OUTPUT TO DAC
3F14 E6   C4        00230           LDB     ,U           GET DELAY COUNT
3F16 5A             00240 RAN020    DECB                   DEC DELAY COUNT
3F17 26   FD        00250           BNE     RAN020         GO IF NOT 0
3F19 31   3F        00270           LEAY    -1,Y         DECREMENT # ENTRIES
3F1B 26   F2        00290           BNE     RAN010       GO IF NOT 0
3F1D AE   41        00300           LDX     +1,U       GET REPEAT COUNT
3F1F 30   1F        00310           LEAX    -1,X       DECREMENT
3F21 AF   41        00320           STX     +1,U       STORE BACK
3F23 26   E5        00330           BNE     RAN005     GO IF NOT 0
3F25 39             00340           RTS              RETURN
          0000      00350           END
00000 TOTAL ERRORS

RAN005  3F0A
RAN010  3F0F
RAN020  3F16
RANDOM  3F07
```

Listing 3

```
3F00                00100           ORG     $3F00
                    00110 ******************************************
                    00120 * SYNTHESIZER                           *
                    00130 * ENTRY: ($3FF0,1)=ON COUNT             *
                    00140 *         ($3FF2,3)=OFF COUNT            *
                    00150 *         ($3FF4,5)=ADSR TABLE ADDRESS   *
                    00160 *         ($3FF6,7)=ADSR INCREMENT DELAY *
                    00170 *         ($3FF8)=VOLUME 1-63 IN VVVVVV00 *
                    00180 *         ($3FF9)=# OF INCREMENTS        *
                    00190 ******************************************
3F00 CE   3FF0      00200 SYNTH     LDU     #$3FF0   POINT TO PARAMETERS
3F03 10AE 44        00210           LDY     +4,U     POINT TO ADSR TABLE
3F06 AE   46        00220           LDX     +6,U     GET INCR DELAY
3F08 A6   A4        00230 SYN020    LDA     ,Y         GET VALUE
3F0A E6   48        00240 SYN030    LDB     +8,U       GET VOLUME
3F0C 30             00250           MUL                FIND DAC VALUE
3F0D B7   FF20      00260           STA     $FF20      SET DAC ON
3F10 EC   C4        00270           LDD     ,U         GET ON CNT
3F12 30   1F        00280 SYN040    LEAX    -1,X         DEC INT CNT
3F14 26   08        00290           BNE     SYN050       GO IF NOT 0
3F16 31   21        00300           LEAY    +1,Y         PNT TO NEXT SEG
3F18 6A   49        00310           DEC     +9,U         DEC # OF INT
3F1A 27   1F        00320           BEQ     SYN090       DONE IF 0
3F1C AE   46        00330           LDX     +6,U         INIT INT DELAY
3F1E C3   FFFF      00340 SYN050    ADDD    #-1          DEC ON CNT
3F21 26   EF        00350           BNE     SYN040       GO IF NOT 0
3F23 7F   FF20      00360           CLR     $FF20      SET DAC OFF
3F26 EC   42        00370           LDD     +2,U       GET OFF CNT
3F28 30   1F        00380 SYN060    LEAX    -1,X         DEC INT CNT
3F2A 26   08        00390           BNE     SYN070       GO IF NOT 0
3F2C 31   21        00400           LEAY    +1,Y         PNT TO NEXT SEG
3F2E 6A   49        00410           DEC     +9,U         DEC # OF INC
3F30 27   09        00420           BEQ     SYN090       DONE IF 0
3F32 AE   46        00430           LDX     +6,U         INIT INT DELAY
3F34 C3   FFFF      00440 SYN070    ADDD    #-1          DEC OFF CNT
3F37 26   EF        00450           BNE     SYN060       GO IF NOT 0
3F39 20   CD        00460           BRA     SYN020     GO FOR NXT CYCLE
3F3B 39             00470 SYN090    RTS              RETURN
          0000      00480           END
00000 TOTAL ERRORS

SYN020  3F08
SYN030  3F0A
SYN040  3F12
SYN050  3F1E
SYN060  3F28
SYN070  3F34
SYN090  3F3B
SYNTH   3F00
```

Continued from page 69

it or not, because assembly language is not fast enough. Consider a sine wave of 1000 cycles per second. Each cycle of the sine wave is 1/1000th of a second long, or one millisecond. If the sine wave table has, say, 32 values, that makes the time between values output to the DAC about 30 microseconds, or 30/1,000,000th second. Even assembly language can just squeak by with those time constraints. A typical assembly-language instruction takes about five microseconds, and we're talking about not much time left over to do other overhead functions.

Figure 3. *Waveshape produced for SOUND.*

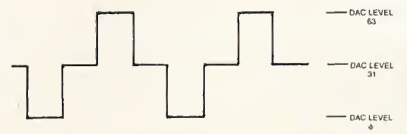


Figure 4. *Attack, Sustain, and Release graphs.*

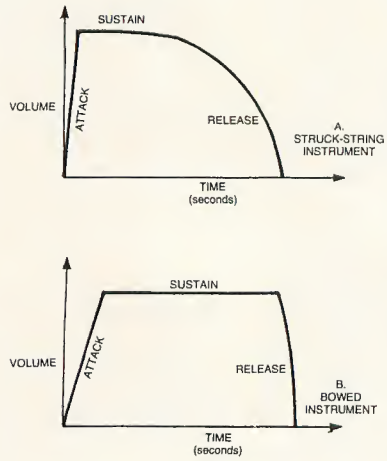
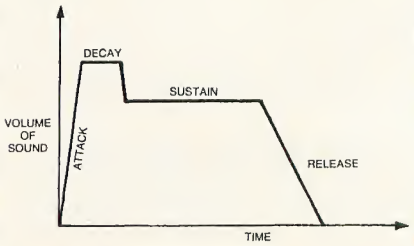


Figure 5. *ADSR envelope.*



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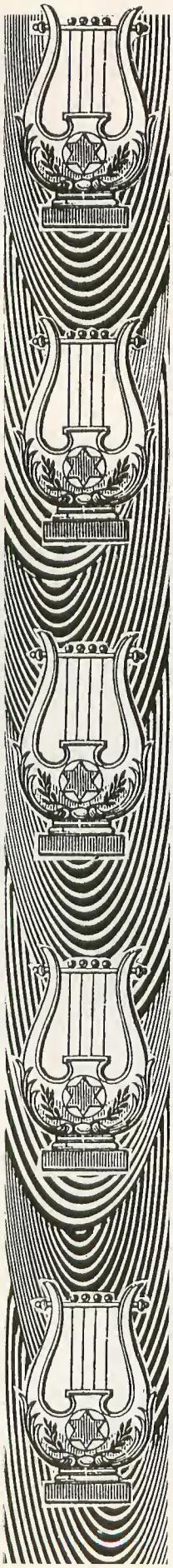


Continued from page 70

Of course, we could cut down on the number of entries in the table. I picture some Microsoft programmer coding this routine and starting out with a full-fledged table of sine values, and finally throwing up his hands and saying, "It'll have to be three levels!" And that's what every sound produced by SOUND has — three levels.

Just for reference, here's a table of values for SOUND, taken from a 16K Color Computer with Extended Color Basic (see Table 2). The format of SOUND is:

SOUND F,D

where F is a frequency value of 1 through 255 and D is a duration count of 1 through 255. Each duration count is about 68 milliseconds (68 thousandths of a second) long.

Table 2

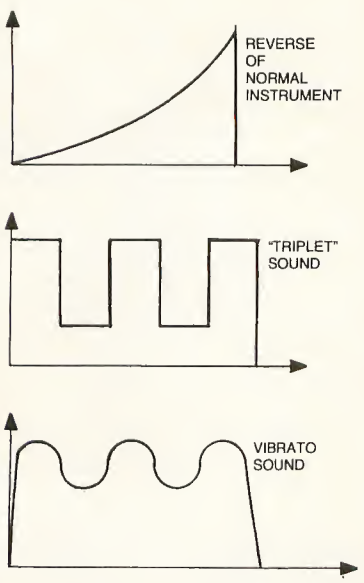
Sound F Value	Frequency (Hertz)
255	6896
250	3846
240	1923
230	1351
220	1041
210	833
190	595
180	500
170	444
160	400
150	370
140	338
130	322
120	299
110	277
100	260
90	244
80	230
70	212
60	204
50	192
40	185
30	175
20	166
10	164

Coda

You can't do much with SOUND, but you can do more with PLAY. PLAY is geared to musical notes covering five octaves. You can specify note values, including sharps and flats, octave values (1 – 5), note length values (1 – 31), and pause (rest) values (1–255). The X command lets you execute substrings.

PLAY obviously uses the SOUND routine in ROM (in Color ROM, not Extended Color ROM) to produce the tones. So, PLAY offers a nice range of notes with volume control, but we're after bigger game...

Figure 6. *Possible waveshapes under variable ADSR.*



Third Movement — ADSR Scherzo

Is there a better way to generate musical sounds than with the PLAY/SOUND commands in Basic? Although PLAY/SOUND provides five octaves of tones with volume, tempo, and duration control, it still doesn't provide many of the things that make music sound interesting. One of the things you can do with a computer is *synthesize* different sounds — the sound of a piano, or a cello or maybe even a sound that doesn't have any comparable instrument quality. We'll set this as our goal — to control pitch and volume, but to add another dimension, creating different sounds — not just the single sound of a three-level pseudo sine wave.

To provide ourselves with background on creating unique sounds, let's look at typical sounds, as shown in Figure 4. The first of these is an instrument whose strings are struck, like a piano (Figure 4a). The graph shows the volume of the sound produced on the vertical axis and the time over which the sound occurs on the horizontal axis. The energy of the hammer striking a string is rapidly transmitted to the string, and the result is an almost instantaneous sound. The sound then dies away in seconds. The next sound is shown in Figure 4b, a bowed instrument like a violin. The build-up time is longer and is sustained as long as the bow is drawn across the string. The

Continued on page 74

Figure 7. *On count and off count parameters.*

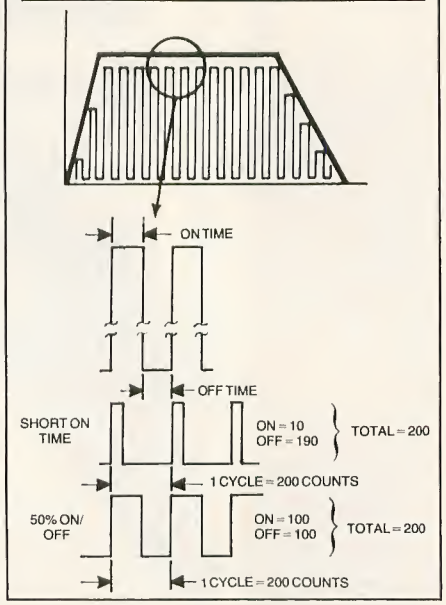
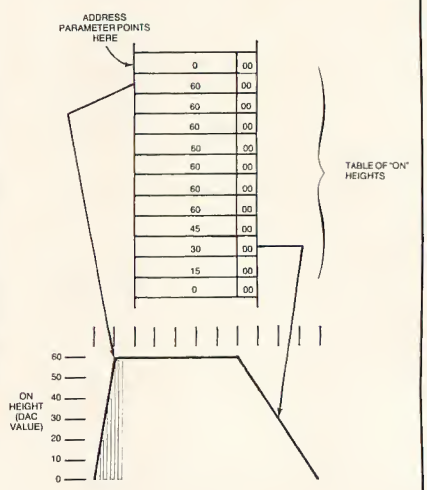


Figure 8. *ADSR Table.*



Continued from page 73

sound dies away more rapidly than the piano sound.

The envelope shape helps define the characteristic sound of the instrument, and can be divided into *attack, sustain,* and *release* portions. The attack portion is the initial build-up, the sustain is the sustained sound (for example, the bowing of a violin), and the release is the time it takes the sound to die away.

Another portion of the waveform that could be defined is *decay* time. This is the time immediately following the attack, and occurs primarily in electronic synthesizers and not in real instruments. The attack, decay, sustain, and release envelope is called an ADSR envelope, and that's what we'll be referring to here (see Figure 5).

What's going on inside the envelope? Unfortunately, inside the envelope is a complex waveform made up of the combinations of musical tones produced by the instrument we are synthesizing. Each instrument has its own timbre during each portion of the ADSR; there is no non-electronic instrument that produces a pure sine wave, of course. Duplicating the characteristics of the instrument inside the envelope is simply not possible with the (slow-speed!) processing we

Listing 4

```
50 DATA &HCE,&H3F,&HF0,&H10,&HAE,&H44,&HAE,&H46,&HA6,&HA4
51 DATA &HE6,&H48,&H3D,&HB7,&HFF,&H20,&HEC,&HC4,&H30,&H1F
52 DATA &H26,&H08,&H31,&H21,&H6A,&H49,&H27,&H1F,&HAE,&H46
53 DATA &HC3,&HFF,&HFF,&H26,&HEF,&H7F,&HFF,&H20,&HEC,&H42
54 DATA &H30,&H1F,&H26,&H08,&H31,&H21,&H6A,&H49,&H27,&H09
55 DATA &HAE,&H46,&HC3,&HFF,&HFF,&H26,&HEF,&H20,&HCD,&H39
56 CLEAR 200,&H3EFF
57 FOR I=&H3F00 TO &H3F3B
58 READ A: POKE I,A
59 NEXT I
100 REM BASIC PROGRAM FOR GENERAL TEST
110 DEFUSR0=&H3F00
120 FOR I=&H3F80 TO &H3F90
130 POKE I,254
140 NEXT I
150 INPUT OC,FC,IN,V,NI
160 TB=&H3F80
170 POKE &HFF01,PEEK(&HFF01)AND&HF7
180 POKE &HFF03,PEEK(&HFF03)AND&HF7
190 POKE &HFF23,PEEK(&HFF23)OR8
200 POKE &H3FF0,INT(OC/256)
210 POKE &H3FF1,OC-INT(OC/256)*256
220 POKE &H3FF2,INT(FC/256)
230 POKE &H3FF3,FC-INT(FC/256)*256
240 POKE &H3FF4,INT(TB/256)
250 POKE &H3FF5,TB-INT(TB/256)*256
260 POKE &H3FF6,INT(IN/256)
270 POKE &H3FF7,IN-INT(IN/256)*256
280 POKE &H3FF8,V*4
290 POKE &H3FF9,NI
300 A=USR0(0)
310 GOTO 150
```

Figure 9. *Envelope segment delay count (increment delay).*

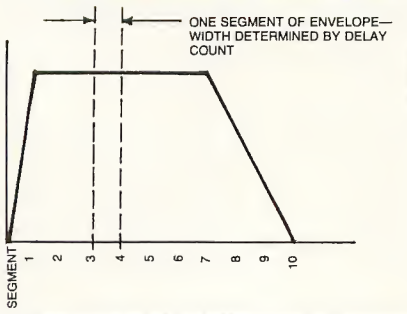
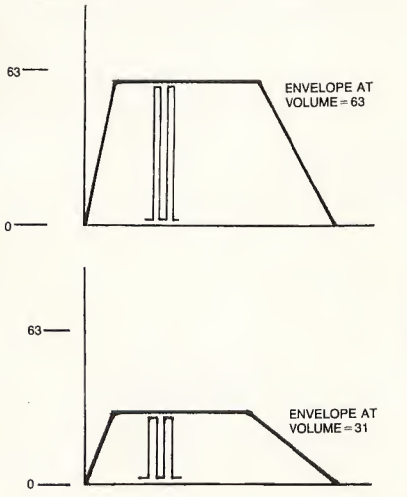


Figure 10. *Volume parameter.*



have available in assembly language.

Electronic synthesizers can generate a variety of different sounds by generating a square wave, or other regular waveform, and then filtering out the slower or higher frequency, components of the waveform. Unfortunately, the Color Computer doesn't have filtering capability (though we could add it externally). We'll have to make do with a simple waveform inside the envelope to make it less of a chore to generate the waveform under program control.

In spite of this limitation, however, the sounds produced under a variable ADSR envelope will be quite flexible, and we can come close to simulating certain instruments. We can also do some things that just can't be done in the real world, such as generating *strange* envelopes, as shown in Figure 6. As a matter of fact, we can define any envelope we wish!

Fourth Movement — Allegro con Synthesizer

The culmination of our efforts as a synthesizer is a Color Computer assembly-language program, shown in Listing 3.

This program uses a parameter block of six variables at locations $3F00 through $3F09, plus an envelope table. The parameter block and envelope table are easy to set up in Basic, and I'll show you how to do it. First let's talk about the SYNTH assembly-language program.

Listing 5

```
50 DATA &HCE,&H3F,&HF0,&H10,&HAE,&H44,&HAE,&H46,&HA6,&HA4
51 DATA &HE6,&H48,&H30,&HB7,&HFF,&H20,&HEC,&HC4,&H30,&H1F
52 DATA &H26,&H08,&H31,&H21,&H6A,&H49,&H27,&H1F,&HAE,&H46
53 DATA &HC3,&HFF,&HFF,&H26,&HEF,&H7F,&HFF,&H20,&HEC,&H42
54 DATA &H30,&H1F,&H26,&H08,&H31,&H21,&H6A,&H49,&H27,&H09
55 DATA &HAE,&H46,&HC3,&HFF,&HFF,&H26,&HEF,&H20,&HCD,&H39
56 CLEAR 200,&H3EFF
57 FOR I=&H3F00 TO &H3F3B
58 READ A: POKE I,A
59 NEXT I
100 REM BASIC PROGRAM FOR "DUTY CYCLE"
110 DEFUSR0=&H3F00
120 FOR I=&H3F80 TO &H3F90
130 POKE I,254
140 NEXT I
150 POKE I,0
160 INPUT F,IN,V,NI
170 FOR I=10 TO F-10 STEP 5
180 OC=I: FC=F-OC
190 TB=&H3F80
200 POKE &HFF01,PEEK(&HFF01)AND&HF7
210 POKE &HFF03,PEEK(&HFF03)AND&HF7
220 POKE &HFF23,PEEK(&HFF23)OR8
230 POKE &H3FF4,INT(TB/256)
240 POKE &H3FF5,TB-INT(TB/256)*256
250 POKE &H3FF6,INT(IN/256)
260 POKE &H3FF7,IN-INT(IN/256)*256
270 POKE &H3FF8,V*4
280 POKE &H3FF9,NI
290 POKE &H3FF0,INT(OC/256)
300 POKE &H3FF1,OC-INT(OC/256)*256
310 POKE &H3FF2,INT(FC/256)
320 POKE &H3FF3,FC-INT(FC/256)*256
330 PRINT OC,FC
340 A=USR0(0)
350 NEXT I
```

Table 3

Variable	Description	Allowable Values
ON	On count: defines duty cycle	1–65,535. 1–400 typical
FC	Off count: defines duty cycle	1–65,535. 1–400 typical
IN	Increment delay: defines segment width	1–65,535. 1–1000 typical
V	Volume: overall volume of sound	1–63.63 is maximum, 1 is minimum
NI	Number of increments in ADSR table	1–255. Depends on ADSR table size; 16–32 typical

Figure 11. *Establishing the number of envelope segments.*

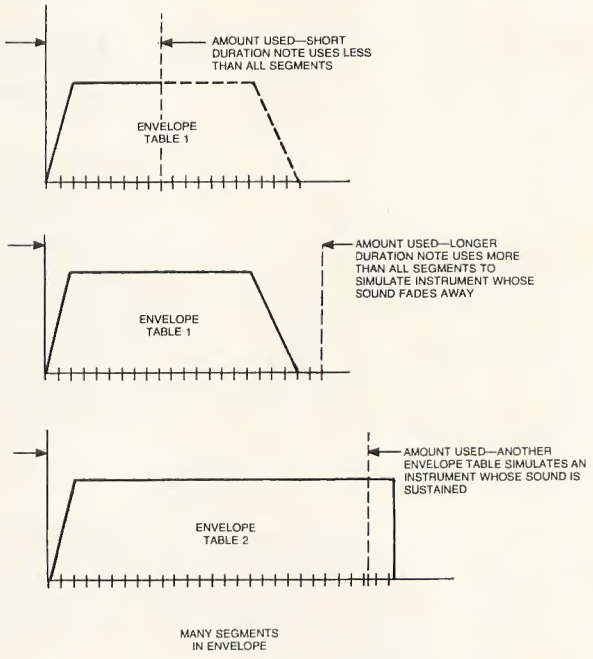
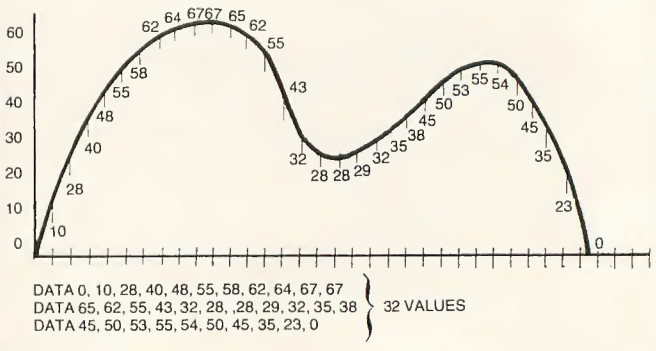


Figure 12. *Generating your own ADSR.*



The On Count and Off Count parameters define the shape of the waveform inside the envelope, as shown in Figure 7. The longer the counts, the lower the frequency or pitch of the waveform. A perfect square wave will have equal on and off counts, as shown in the figure. Either the on or off portions of the wave can be varied to produce different "duty cycles" (ratio of on to off portions of waveform). Remember that for the same fundamental frequency (pitch) of sound, the total of the on and off counts must be constant. That is, you might have 10 and 190 for on and off counts in one case, and 100 and 100 in a second case. The total is 200 in both cases, and the basic frequency of the note will be the same. The note will sound different, however, and we'll discuss why shortly.

The third parameter in the parameter block is the address of the ADSR envelope table. This table defines the shape of the envelope by defining the maximum height of each on portion of the waveform, as shown in Figure 8. The table concept is similar to the random-noise program discussed earlier. The ADSR envelope table can be located anywhere in memory.

The fourth parameter in the parameter block is a delay count between segments of the envelope, as shown in Figure 9. The greater the delay count, the longer the envelope will be stretched out over time.

The fifth parameter in the parameter table is the envelope's over-all volume. The envelope table determines the envelope's shape, but the basic shape can be increased or decreased in over-all volume by varying this parameter, as shown in Figure 10.

Finally, the last parameter defines the number of segments in the envelope (see Figure 11). The envelope table and increment delay establish the over-all duration of the envelope. A piano note might last for three seconds, for example, and the envelope table might have 32 entries of 3/32 seconds each, established by the increment delay. The number of segments changes to reflect the duration of the note. For a sharp, staccato note on the piano you might want 1/8 second, or four segments. A normal note might last 16 segments, corresponding to a whole note at a slow tempo. The number of entries in the envelope table, the increment delay, and number of increments can be used together depending upon whether you wish to simulate an instrument that sustains a note (such as a stringed instrument or horn) or an instrument that doesn't sustain a note (such as an harpsichord or drum).

To show you how this program interfaces with Basic, take a look at Listing 4. This Basic program first relocates the machine-language code of SYNTH to the $3F00 area; it then builds an envelope table in the $3F80 area. The remainder of the program simply takes your input and plays a note based on your input parameters. DC is on count, FC is off count, IN is increment delay, V is volume, and NI is number of increments. Table 3 shows the allowable values for each of these pa-

Please turn to page 78

Listing 6

```
50 DATA &HCE,&H3F,&HF0,&H10,&HAE,&H44,&HAE,&H46,&HA6,&HA4
51 DATA &HE6,&H48,&H3D,&HB7,&HFF,&H20,&HEC,&HC4,&H30,&H1F
52 DATA &H26,&H08,&H31,&H21,&H6A,&H49,&H27,&H1F,&HAE,&H46
53 DATA &HC3,&HFF,&HFF,&H26,&HEF,&H7F,&HFF,&H20,&HEC,&H42
54 DATA &H30,&H1F,&H26,&H08,&H31,&H21,&H6A,&H49,&H27,&H09
55 DATA &HAE,&H46,&HC3,&HFF,&HFF,&H26,&HEF,&H20,&HC0,&H39
56 CLEAR 200,&H3EFF
57 FOR I=&H3F00 TO &H3F3B
58 READ A: POKE I,A
59 NEXT I
100 REM BASIC PROGRAM ADSR
110 DEFUSR0=&H3F00
120 DATA 0,31,63,63,63,63,50,48,46,44,42,40
130 DATA 38,36,34,32,30,28,26,24,22,20,18,16,14,12,10,8,6,4,2,0
140 FOR I=0 TO 31
150 READ A
160 POKE &H3F80+I,A*4
170 NEXT I
180 INPUT OC,FC,IN,V,NI
190 TB=&H3F80
200 POKE &HFF01,PEEK(&HFF01)AND&HF7
210 POKE &HFF03,PEEK(&HFF03)AND&HF7
220 POKE &HFF23,PEEK(&HFF23)OR8
230 POKE &H3FF0,INT(OC/256)
240 POKE &H3FF1,OC-INT(OC/256)*256
250 POKE &H3FF2,INT(FC/256)
260 POKE &H3FF3,FC-INT(FC/256)*256
270 POKE &H3FF4,INT(TB/256)
280 POKE &H3FF5,TB-INT(TB/256)*256
290 POKE &H3FF6,INT(IN/256)
300 POKE &H3FF7,IN-INT(IN/256)*256
310 POKE &H3FF8,V*4
320 POKE &H3FF9,NI
330 A=USR0(0)
340 GOTO 180
```

Continued from page 77

rameters and gives a description of each. Use the Basic program to experiment with various values and see how the notes sound.

The Basic program in Listing 5 is similar, but it varies the duty cycle of each note so you can see how the sound changes with different duty cycles but the same basic frequency. There's a surprising range of sounds, due to the different frequency components of the rectangular waveform.

The last Basic program (Listing 6) lets you build your own ADSR or envelope table of 32 entries. Start by drawing the basic waveform on a sheet of quadrille paper marked off with a vertical scale of 0 – 63 and a horizontal scale of 0 – 32 (see Figure 12). Incorporate the 32 data values in the Data statements, and then input different parameters (as in the first Basic program).

Space doesn't permit me to expand upon these concepts to build a complete Basic program to simulate the Basic's PLAY command. However, you can see this wouldn't be too difficult, given the assembly-language program which allows a wide range of frequencies, note durations, volume, and waveshapes. If there's enough interest in this subject, I'd be happy to provide a Basic driver for SYNTH.

Of course, we haven't scratched the surface of special techniques that could be implemented in the Color Computer sound circuits. Functions such as several voices (polyphony), glides (from one note to another), or reverberation are possible, along with voice synthesis.

If you're interested in further reading, I recommend the following:

- *Musical Applications of Microprocessors,* Hal Chamberlin, Hayden Book Company, 1980: Comprehensive book about music generation.
- *A Guide for Using the PAIA 4700/S Synthesizer System,* PAIA Electronics, Inc., 1020 W. Wilshire Blvd., Oklahoma City, OK 73116: Contains basic material on synthesizers, may be purchased separately.
- *Friendly Stories about Computers/Synthesizers,* John S. Simonton, Jr., PAIA Electronics: Although describing PAIA products, contains a great deal of basic fundamental theory.
- *Music, Physics, and Engineering,* Harry F. Olson, Dover Publications: Basic text on instruments and sound theory.
- *TRS-80 Models I, III, and Color Computer Interfacing Projects,* William Barden, Jr., Howard W. Sams and Co.,: Voice sampling and synthesis in the Color Computer. Heartily recommended as I need the money... ■ ■ ■

Table 1. Features

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RETAIL	$58.95	$123	both together $49.95		$109.95
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Saves Screens to	C	C and D	C	C and D	C
Type of Editor	Screen loaded from tape		FIG resident		Hybrid resident
Quality of Documentation	Poor		Very Good		Good
Save Pre-Compiled System	N		Y		Y
M/L definitions	Y		Y		Y
Graphic words	Y*		N		Y
Support Printer	Y		Y		Y
Comments	Best editor. Manipulates interrupts. Do multi tasking. Adding ROM to Disk is complicated with many hardware modifications, recommended for experts only. Can trace program execution.		Does include tutorial. Worst editor. Clumsy with Screen I/O to tape. Best disk system.		ROM leaves space for programs. Easy to use graphics words. Does include cross reference to Starting Forth book. ROM source code supplied.

*Not easy to use

FORTH: WHAT IS IT? Some say it's a computer language, others say an operating system or a programming environment. I've worked with the language for over three years, I know it inside out, and I still haven't figured it out. Two things are apparent, though — it's not for everybody, but if you like it, you won't be able to get enough of it.

Here are two rules of thumb that usually indicate an interest in FORTH. Do you look at Basic, get frustrated with its limitations, and wish you could learn assembly language? If so, FORTH is a compromise between Basic and assembly language in its power and the ease with which it can be learned. Do you find yourself writing complicated programs or programs that use a lot of PEEKs and POKEs? Do you really like to manipulate the insides of your Color Computer? If so, FORTH is definitely your language because it's very good at managing large, complicated programs and manipulating the hardware and software of a computer.

FORTH is powerful because it has extensibility — you can customize it to suit your needs. In fact, every program you write is such a customization. The most important thing is that the parts you add on are automatically welded into the language and are treated by FORTH as if they had always been there. For example, if you want to take the maximum of two numbers, in Basic you have to write a subroutine to do so, juggle values in and out of preset variable names, and interrupt a calculation with a GOSUB statement. With FORTH you can create a short program (or word), called MAX and use it inside any calculation, just as you would the more familiar words like + and /.

All these factors contribute to FORTH being a more powerful, more responsive language. Many programmers claim (and this is where the religious fervor toward FORTH starts), that they can write a program and get it working faster in FORTH than in other languages. I have found this to be the case to some extent myself. When you add to that the fact that FORTH programs are more compact (important when you have only 16K of memory), and run faster, FORTH seems pretty attractive.

FORTH has three main advantages: complete control over the computer, extensibility, and increased productivity. Its main disadvantages are its unusual language structure and notation, and its do-it-yourself nature.

Advantages

FORTH commands are closer to the internal machine language the Color Computer uses than they are to, say, Basic commands. Because of this, you can do the kinds of things assembly-language programmers do, things that could be done in Basic but aren't because the language is too slow or tedious. For example, you can read or write to disk or cassette more easily in FORTH than in Basic. What's more, FORTH doesn't force you to read data in a certain format — you read it in its raw form and you decide how to interpret it. In addition, you can freely add machine language into FORTH programs to make them faster, something that is done with great effort — if at all — in Basic. *Please turn to page 82*

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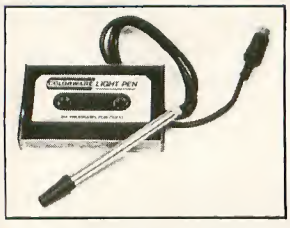

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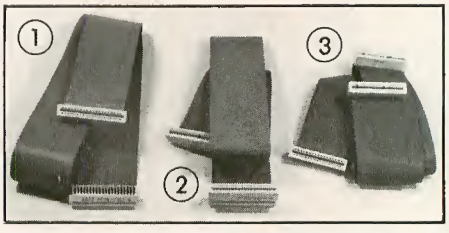

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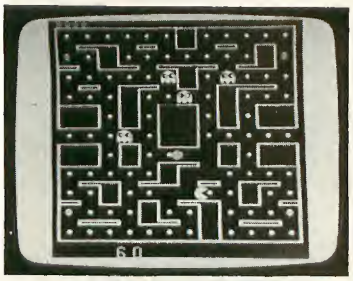
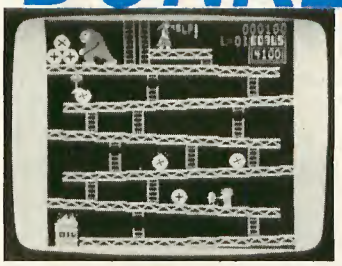


GHOST GOBBLER

From Spectral Associates, this "Pac" theme game is the best of it's type. Brilliant color, action and sound, just like an arcade gobble your way to glory, but watch for those ghosts! Get in on the wild fun of this game craze now. Requires 16K. Tape: $21.95, Disk: $25.95

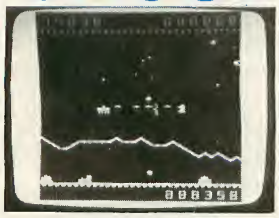
GHOST GOBBLER

DONKEY KING



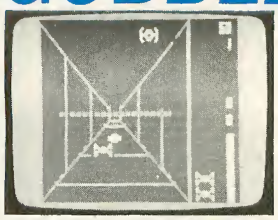
DONKEY KING

You simply can not buy a more impressive game for your color computer than this new wonder from Tom Mix. The graphics, sound, and animation are all just astonishing! There are four different graphic screens and each is endless fun. Requires 32K. Tape: $24.95, Disk: $27.95



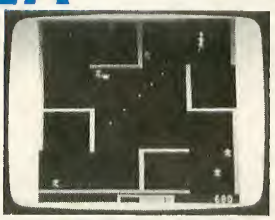
PROTECTORS

There are several good versions of the "Defender" theme available for the CoCo. None, however, rival this one from Tom Mix. No other game matches the detailed graphics and sheer excitement of this top seller. Requires 32K. Tape: $24.95, Disk: $27.95



INTERGALACTIC FORCE

Your space fighter roars into the Death Corridor. Lock-on and blast the enemy fighter from the sky. Now try dropping one into Death Star's narrow exhaust vent. It takes skill and guts. Good luck! With "Star Wars" theme song. From Anteco. Requires 16K. Tape: $24.95

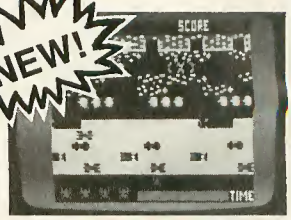


ANDROID ATTACK

Spectral Associates' very well done "Berserk" type game with some interesting added features. Each cassette contains both the 16K and 32K version. The 32K version has voice output! Plenty of action. Tape: $21.95

CREATURE FEATURE

From Color Software, comes a lightening swift shoot & dodge the enemy game. It's clever cross between "Robotron" and "Beserk" themes, with bullets flying everywhere. Solid, shoot-em-up-fun. Requires 16K. Tape: $17.95. Disk: $19.95



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Just released by The Cornsoft Group, this is the officially licensed version from Sega, the arcade manufacturer. It has it all! 4 lane super highway, snakes, turtles, logs, alligators, etc. Lots of action and laughs! Requires 16K. Tape: $19.95

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Disadvantages

Now for the disadvantages. FORTH is a strange language, and some people never get used to it. One very good book will help you along, *Starting FORTH*, by Leo Brodie (Prentice-Hall, 1981, $16 in paperback — it can be ordered from your local bookstore). If I had had this book when I was learning FORTH, it would have saved me about a year's worth of confusion and exasperation. Buy it before you buy any of the FORTHs reviewed here; you'll need it anyway, and it will give you a good idea of what the language is about.

The FORTH language has a strange structure. I can't teach FORTH here, but I will say its structure is at the heart of the advantages listed above — you can't have one without the other. One of FORTH's unusual features is its use of reverse Polish notation — for example, in Basic, you say 3+5, but in FORTH you say 3 5 + (note the spaces between the numbers and the plus sign). Another oddity of FORTH is its use of a memory area called the *stack*, where numbers are temporarily stored; this leads to cryptic-looking programs because, instead of storing results in variables, programmers often store them (without names) on the stack.

A final disadvantage of FORTH is that, in many ways, it is not so much a language as it is the skeleton of a language on which you can build. My favorite saying about FORTH is that you can do anything in FORTH, but you will probably have to do it yourself (i.e., it probably isn't in the language and you'll have to add it to the language yourself). For example, most FORTHs (including those listed in this article) do not have floating-point numbers, graphics commands, or arrays; you must create them yourself. (In some cases you can write short FORTH words that use certain subroutines that are in the Color Computer Basic ROMs; this is often easier than creating them yourself.)

To summarize, FORTH offers extra power but demands extra work on your part. It is a wonderful language for someone who wants to roll up his sleeves and really make the Color Computer do some tricks. Just as there are hardware hackers that build hardware from scratch, FORTH is the ultimate software hacker's language.

What is FIG-FORTH?

FORTH was invented in 1969 by Charles Moore, who originally used it to acquire data for a radio telescope. Moore created the company FORTH Inc. to license and support the FORTH language as he conceived it. Over the years, FORTH became more popular and was converted to many computers by FORTH enthusiasts. In 1978, some of these people created the FORTH Interest Group (FIG) and, by 1979, had created a version of FORTH called FIG-FORTH. They documented this software and released it in the public domain to show people how FORTH works and how to create their own versions of FORTH.

To make a long story short, most software vendors decided to implement the FIG-FORTH model (as it was called) for a given machine instead of creating a version from scratch. Even though new FORTH standards have appeared, FIG-FORTH is still, so far, the most popular form of the language. All the FORTHs reviews here are implementations of the FIG-FORTH model. Each company has made its own set of extensions to its version of FORTH to allow it to interact with the Color Computer.

A Brief Example

I have tried to describe the essence of

FORTH in the hope it will correctly lead you to explore or pass by the language. I will give you a short example of FORTH programming so you can get an even better feel for the language.

Listings 1a and 1b show equivalent short routines in FORTH and Basic, respectively, to switch the Color Computer into the graphics mode called G1R (128 by 64 pixels, two colors); the lines of code are in a one-to-one correspondence. A FORTH definition (here, the word "G1R") begins with a colon and the name of the definition. All the words that follow, up to the ending semicolon, are a list of words that is executed when the word being defined is later executed. Although the indentation used here is not necessary, at least one space between each set of characters is — each set of characters is a FORTH word, and FORTH looks specifically for space to tell it where a word begins and ends.

Unlike most languages, which put values after keywords (for example, "POKE 65476,0"), FORTH puts them before ("0 65476 C!"); this is because numbers usually go onto the stack first and are then pulled off the stack by a keyword. Notice that the word C! in FORTH is equivalent to Basic's "POKE." Note also that another FORTH word, !, is equivalent to two Basic POKEs — it is, in fact, a 16-bit POKE, a feature that Color Computer Basic doesn't have. This is only a very mild example of some of the advantages that FORTH has over Basic. One nice thing about FORTH: if you don't like a word name, you can change it. Executing the FORTH code

```
: POKE C! ;
```

lets you substitute the word POKE for the more cryptic C!.

Program Listings 2a and 2b give you, along with Listing 1a, enough words to play with G1R graphics within FORTH; they also serve as an example showing how you can add to the language functions that aren't necessarily in the language as you receive it from the manufacturer. The FORTH word "1024 MEM" points the video display to the top 1K of memory in a 16K machine. The word "102CLEAR" clears that area to blanks so you can build a video image from a clean display.

The word "1024CLEAR" in Listing 2c does the same thing as Listing 2b; the new version shows how a specialized FORTH word (here, the word "FILL") can make the definition of a new word much easier. FORTH has many such useful words.

To execute these words, type them in, one at a time, pressing Enter after each word. To put some kind of image on the resulting G1R screen, POKE values into the memory locations between 15360 and 16384. You can do this by typing in the phrase:

<value to store> <address> C!

Remember to separate these elements by spaces and finish by pressing Enter.

Please turn to page 84

Listing 1a and 1b

```
: G1R  ( go to graphics)
       ( mode G1R)
   0 65473 !
   0 65476 C!
   65314 DUP C@ 144
    + SWAP C!
```

```
9000 REM--GO TO MODE G1R
9010 POKE 65473,0:POKE 65474,0
9020 POKE 65476,0
9030 POKE 65314,PEEK(65314)+144
9040 RETURN
```

Continued from page 82

Listing 2a

```
: 1024MEM ( set video display to start at 15360)
          ( see pages 260, 263 of "Getting Started with)
          ( Color BASIC" book for details)
   0 65478 C!
   0 65481 C!
   0 65483 C!
   0 65485 C!
   0 65487 C!
   0 65488 C!
   0 65490 C!
;
```

Listing 2b

```
: 1024CLEAR   ( clears 1024 bytes of memory,)
              ( starting at 15360)
   16385 15360 DO
      0 I !
   2 +LOOP
;
```

Listing 2c

```
: 1024CLEAR'   ( alternate version of 1024CLEAR)
   15360 1024 0   FILL
;
```

The Color FORTH Chart

Most of the information about the three FORTHs I compared is in Table 1. The following paragraphs explain the significance of some of the lines of information.

- Interact with disk? — FORTH makes heavy use of FORTH source code stored in 1K byte areas of memory called screens, which need to be saved permanently for later use. Of course, I highly recommend a disk system, but cassette users are probably used to the inconvenience of using cassette tape.
- Save precompiled system? — With a disk and certainly with a cassette, loading a FORTH system from screens is slow and tedious. For some FORTHs, you can save the current system (with your definitions added) as a single machine-language file just like the file you load to get Color FORTH into your machine in the first place. This feature saves you a great deal of time if you have FORTH code you want to use every time you use the system. Most people customize their FORTH in various ways, save that as a precompiled system, then load that version of FORTH at the beginning of subsequent work sessions.
- Supports machine-language definitions? — As I said before, you can define FORTH words in terms of previously defined FORTH words or in terms of 6809 machine language. Although the latter is more difficult, it offers you the ultimate in speed. Machine-language definitions are usually used sparingly to speed up a working but sluggish FORTH program.
- Type of editor — The editor is the program you use to put information on screens. A line editor forces you to deal with one line of text at a time. Since a line is usually 64 characters and the Color Computer's screen is 32, it is annoying to have to worry whether you've put too much text on a line. A screen editor is preferable because it gives you a blank screen on which you make changes via commands that let you move the cursor around the screen and make changes at its current location.
- Quality of documentation — Even though you should have Brodie's *Starting FORTH*, the documentation is your only link to the special features of a given implementation. The documentation is your main tool for understanding a version of FORTH, and you will be spending a lot of time reading it. Its quality, even more than that of the language itself, will influence your feelings about the product. Be aware of this influence.

Given these opening comments and the information in Table 1, look at the individual versions of FORTH for the Color Computer (they are listed in no particular order).

Hoyt Stearns Color-FORTH

THIS VERSION of FORTH (priced at $58.95, $123 with the optional ROM version) has some good features, but its inadequacies cause me to recommend against buying it. It is the best of all the editors reviewed, but has to be loaded from tape every time you need it. This is a tedious process that cannot be circumvented because there is no way to save the FORTH-plus-editor combination as a precompiled system

The entire system, including some potentially useful advanced features, is marred by poor documentation. The documentation is often confusing or entirely absent. For example, the screen editor, when executed, gives a cryptic prompt line that is not explained anywhere. In addition, this implementation is not explained in a consistent way. Some material is thrown in without sufficient explanation; other material is completely irrelevant. For example, the cassette includes an Extended Color Basic maze game called Ratmaze that has nothing to do with FORTH. Stearns' FORTH does include some useful color graphics words, but they are not well explained and require considerable knowledge of the Color Computer graphics hardware to use.

As a representative example of the carelessness used to create this version, let me first explain that the other (by Armadillo) lets you load FORTH by executing the command CLOADM followed by EXEC from Basic. Stearns' FORTH uses a CLOADM followed by (according to the cassette label and the printed documentation), "EXEC &H988 (&H98A cold)." One point I want to make is that it is very little trouble to create a machine-language file so that no beginning address (like 988 hexadecimal) has to be specified — you can simply say EXEC. The other point is that, when I tried to execute EXEC &H988 on my machine, I got the error message ?SN ERROR, which I supposed denoted some syntax error on my part. After some thought, I converted the number 988 hexadecimal into 2440 decimal, tried EXEC 2440, and found that that caused Color-FORTH to work. The problem is that my machine, which does not have Extended Color Basic, can take addresses specified in decimal only. Mr. Stearns forgot to add this information to his documentation. It is a small point, but it is indicative of many others.

Mr. Stearns also sells a ROM version of his product, but you have to modify a

Please turn to page 86

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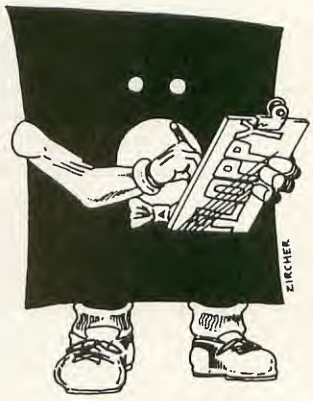

The Disk Manager

If you use a disk drive you NEED this program! It does more than any other disk utility. You can use it to rebuild a crashed disk easily - two different ways. You can also print a SUPER DIRECTORY for a disk that contains such information as program size, which granules are used, and the start, end, and execute addresses for machine language programs. It will also print a menu on the screen for a disk in the drive, and when you indicate your choice it will load and either RUN or EXEC the program for you as appropriate. In addition, it codes your files by DATE, and it codes your disks by NAME and NUMBER. And, it creates and maintains a file of all your disks (and the programs on them) which you can sort and print as needed. You can sort a collection of up to 300 disks. Could you use a printed list of EVERY program in your collection, in alphabetical order? This list tells you which disk has the program you need so you can find it easily, and all this is only the beginning. There are so many features we have no space to mention them all. Both the 16K and 32K versions are included, and we suggest you place a copy of the program on every diskette for quick access. You will wonder how you got along without this beauty!! Full, easy to follow instructions. Requires a disk drive. **$29.95**

NEW THIS MONTH

The Disk Master

This helpful addition to your library performs a whole list of great functions. We've seen programs selling for just as much that do only one or two of these things, and the whole thing is menu driven for ease of use. It provides a speed check and adjustment function to get your drives into perfect adjustment. It moves programs from tape to disk — or disk to tape — or from one drive to another — all effortlessly. It prints a directory — with machine language addresses — to the screen or printer. It gives you two different disk maps. One shows which sectors are used in each gran, and the other shows which grans are available. It even gives you a way to easily purge a number of files from a crowded disk. Why buy a different program for every function, when this does so much? Requires a disk drive. **$24.95**

Your Personal check is welcome - no delay. Include $1.50 shipping for each program ordered. (Shipping free on $50.00 or larger orders). Az. residents add 6% sales tax. Orders shipped within two days.

Monsters & Magic

The most realistic fantasy role-playing game yet for the Color Computer. You start out by rolling up your character's basic ability scores and buying equipment. When you are ready it's into the dungeon. Your character starts at first level, but can rise in levels by garnering experience in the fray. If you have role-played fantasy games you will be amazed at the realism of the combat system. Armor class, initiative, and damage by weapon type are all included, with over 50 different monsters to fight - each with it's own abilities. As you rise in level you can win treasure and find magic weapons and spells - if you live!! You set the game length by telling how many monsters you want to fight before you reach your final battle to the death against the powerful Dungeon Lord. There are 1000+ place description combinations in this text based game, and real excitement in every one! This is a fantasy simulation, and is truly not like any adventure game you have ever seen. For 1 player; requires 32K extended BASIC. **TAPE - $19.95, DISK - $24.95**

Astrology

Truly a classic, this program will accurately cast your complete horoscope. You just enter the date, time, and place of birth. The sun sign, rising sign, mid heaven (MC), lunar nodes, and planetary influences including houses and aspects between the planets will all be calculated, and a full chart drawn. You can also do progressed charts and transits. It will even tell you the day of the week you were born. The accompanying book will help you interpret this chart of your horoscope. The extent of the documentation is tremendous, even by our exceptionally high standards, and no previous knowledge of the subject is required. You can share in this wisdom which has been used for thousands of years in many cultures. This program was written by a professional Astrologer. Please specify 16K or 32K system. **$34.95 tape — $39.95 disk**

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(602) 886-1505

Continued from page 84

cartridge and your Color Computer to use it. The instructions to add this ROM to the floppy disk interface cartridge are 33 steps long, and they include a lot of cutting on your Color Computer — frankly, I wouldn't want to try it. I did not test this version, so I don't know how well it works if you graft it onto the standard disk cartridge (which is supposed to convert his product into a disk-based FORTH).

Armadillo COLORFORTH

WITH A FEW exceptions noted below, I rate this FORTH a best buy. For the modest price of $49.95, you get a cassette and disk version of COLORFORTH (both versions are on cassette, and the disk version must be transferred from tape to disk). In quality, accuracy, layout, and completeness, its documentation is an exact opposite of Stearns'. Complicated procedures are explained in a way that is easy to understand, the documentation is laid out in an organized way, and it even contains several short tutorial sessions that show you how to do a few simple things with FORTH. All the versions reviewed here contain the FIG-FORTH vocabulary list; the other two reproduce these pages photographically (mistakes and all) from the original FIG document, but the authors of this version have thoughtfully retyped the document and made corrections and clarifications where needed — a nice touch.

Armadillo FORTH is, unfortunately, not as good as the other versions in several respects. It has a clumsy but serviceable line editor; if you have the skill you can write your own screen editor, but that doesn't help most of us who can't or don't want to. Its method for saving screens to tape is awkward and even more unusable than the methods used by the other versions (ignore this criticism if you have a disk). Finally, this version includes fewer Color Computer-oriented words than the other versions; true, you can make them up, but it would be nice to have them already done for you.

Micro Works COLORFORTH

THIS IS THE ONLY version supplied in a ready-to-go ROM cartridge. Because it's a hardware product, it is more expensive ($109.95), but you may want to pay the extra price if you hate loading cassettes. (The other two versions load from tape in almost exactly one minute.) Because this version is in ROM, it leaves more space for FORTH programs than the other versions (which use RAM to store FORTH); in addition, this version is the only one that will work on a barebones 4K Color Computer.

Micro Works' editor uses line editor commands, but the results are easier to read than the Armadillo editor because they are displayed on-screen in a partial window of 12 lines of video display. A screen in this version is 32 lines of 32 characters per line; editor commands allow you to see any 12-line chunk of this screen. It is a nice editor, but it is not as good as the Stearns editor.

This version's documentation is very good: it is clear, well-organized, and easy to read. In the cases where the program's implementation in ROM makes it work differently from RAM-based versions, the authors explain the difference and why it is done this way. One particularly nice touch is a list of differences between this FORTH and that described in *Starting FORTH*. The list is keyed to pages

in the Brodie book, and will be a great help to anyone who might not otherwise catch the differences between the FORTH version documented in *Starting FORTH* and the actual implementation they have.

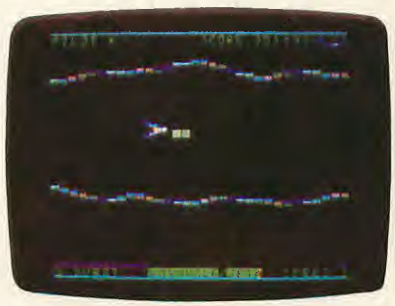
The implementors give good definitions for the special words they add to the sytem; they also include the FORTH source code for many of these words (you can learn a lot about FORTH by reading and trying to understand these definitions). For some reason, they have also included the 6809 assembly language source code (uncommented, unfortunately) for Micro Works COLORFORTH itself. I'm not quite sure why they did this — the listing won't be of any use to 95 percent of the people who buy FORTH.

All in all, it's a good implementation of FORTH with some graphics words implemented that can be used by novice FORTH programmers. According to the documentation, a disk-oriented version is in the works. This may be serious competition to the Armadillo version.

Conclusions

I hope that in addition to telling you about these versions of FORTH, I have given you a feeling for the language. All three are competent implementations of the FIG-FORTH model, but they differ in terms of added features, documentation, and the editor they include. These factors will influence your decision of which version to buy.

FORTH is not for everybody, but it may be for you. If so, I leave you with the time-honored salutation of its devotees; "May the FORTH be with you." Good luck.



Wormtube

Zeta Software
P.O. Box 3522
Greenville, SC 29608
$20.45

This is a different kind of game. The concept is that you are piloting a space ship at speeds faster than light. This creates a tube in space. You have to guide your ship through space without breaking the fabric of this wormtube, which is colorfully represented by jagged bands of light. Every once in a while you encounter a gold bar. You can either maneuver around the bar, or smash it with a topedo. Once smashed you can gather the pieces with the jaws of your ship for extra points.

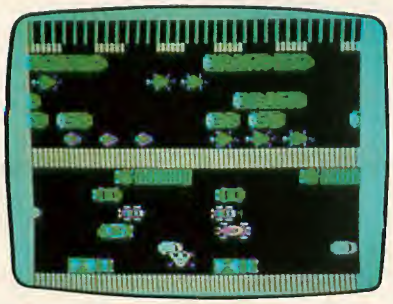
Although I don't think *Wormtube* has enough action to keep an adult's interest, it is not a bad children's game. You start the game with 3,000,000 points. Just maintaining the ship within the wormtube's boundaries wins the player points. Smashing and capturing gold pieces wins more points. Crashing into the fabric of the tube halts the action and costs you points (up to 5,000), as does crashing into an unsmashed gold bar.

Because you begin the game with so many points, it's difficult to lose. And that's what makes it good for children. They can sharpen their hand-eye skills without suffering the negative aspects of losing.

The game can accomodate up to four players at a time. You have nine speed

Please turn the page

options, the ability to halt the action, and save a game in progress. You can also change speeds during the course of the game by pressing the F-key for faster or the S-key for slower. — *K.L. Color staff.*



The Frog

by A. Hubbell
Tom Mix Software
3424 College N.E.
Grand Rapids, MI 49505
$27.95 Tape
$30.95 Disk

TOM MIX software has again turned out a good Color Computer version of a successful arcade game. This latest Tom Mix game, *The Frog*, is, of course, his version of Frogger.

The screen set-up is similar to the original game. You control Frog movement by the arrow keys rather than the joystick. The first half of the screen is a traffic obstacle. The second half is the river. The object of the game is to first cross the road without letting the frog get squished, and then cross the river without letting the frog get eaten. Ultimately, you want your frog to eat a fly at the top of the screen.

The obstacles get more difficult as you get better. After completing the first screen the course gets tougher with the addition of alligators cruising the river. In the third screen snakes are added. The speed and number of cars and trucks also increases. Your final obstacle is the clock. Take too much time crossing the road and river and you risk sacrificing your frog to old age.

Points are awarded for all levels of achievement. For each row advanced you get 10 points. Point values vary for the different pinnacles attained in your frog persona.

The Frog not only promises to give you a whole new outlook on the life of pond dwelling hoppers, it can also bring you romance. Occasionally a frog of the opposite gender floats by on a log in the river. Jump onto her (his) log and take her (him) (it) with you to the top of the screen and earn an extra 200 points. Not only do you get to hook up with a ribitette (ribitour), but you get extra points for your trouble.

Keyboard movement is a bit slower than the arcade version, but that only hampers play once in a while. While the graphics are well done, the sound is no great shakes. The Frog is fun.

— K.L. *Color* Staff

Moon Hopper

by M.G. Lustig
Computerware
4403 Manchester Avenue, Suite 103
Encinitas, CA 92094

IT'S ABOUT TIME someone took the all-time favorite *Space Invaders* and brought it up to date.

You're patrolling the moon in the U.S. Space Patrol's newest moon buggy, the Moon Hopper. It is touted as the perfect vehicle for travel on the moon's surface. The buggy is so good that one day, during routine test maneuvers, the Traglons risk a surprise attack against you hoping to steal your Moon Hopper. What they don't know is that the project's engineer recently interfaced the Moon Hopper's phaser banks to its computer. You have to reach your home base before the Traglons can stop you.

Moon Hopper has five difficulty levels. There are three obstacles between you and the safety of your home base: phaser blasts from Traglon flying saucers, boulders, and craters. As you advance in difficulty levels the craters become more numerous.

Your defenses are the ability to control Moon Hopper cruising speed, jump over craters, and fire phasers simultaneously from the top and front of your vehicle.

Controlling your Hopper along the moon's surface takes practice. Mastering the technique is not too difficult. Once you do, you'll be traversing the moon's surface and dodging phaser blasts like a true space cowboy. — K.L. *Color* Staff

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REVIEW$

Continued from page 88

Shark Treasure

Computerware
Box 668
Encinitas, CA 92024

Just when you thought it was safe to go back in the water... Shark Treasure. This is a fun game. You control divers who are retrieving gold bars from a long-ago sunk Spanish galleon. Each gold bar is worth $1000. You'd be richer faster if it weren't for the fact that the long-gone captain of the ship decided to go down in shark infested waters. But being the smart businessman you are, you hire divers to go down and get the gold for you.

You begin your recovery expedition with $2000. You, being the generous soul that you are, arm your divers with three flash grenades. These grenades do not kill the sharks, but sufficiently scare them into reversing their direction. Your divers have to gather the gold bars judiciously though, as the combined weight of flash grenades and gold bars will keep them from being able to float to the surface. This being the case, each diver can only carry three objects. He leaves the boat with three flash grenades. If he gathers two gold bars at the ocean's bottom he must discard two flash grenades leaving him only one for protection. This is fine for the first few dives, but then the sharks get wind of your presence and increase their patrol of the ingot-laden sea floor.

As the game gets more difficult the treasures get more valuable. Sapphires, rubies, and emeralds are worth more than the gold, but you have to gather a few layers of gold bars before getting to them. Some of the gold is more valuable than other bars. The top price paid for a single bar of gold is $8000.

Game play continues until the sharks take their toll on your diving crew. You must pay $1000 for each diver who becomes shark-lunch. The game is over when the sharks have dined on more crew than you can afford.

— *K.L. Color Staff*

ColorText

Micro School Programs
101 Nickerson Street
Suite 202
Seattle, WA 98109
$79.80 Disk

COLORTEXT IS A Color Computer utility designed to enhance Basic programs by letting the programmer intermix graphics and text on the same screen. ColorText provides an alternate character set with upper- and lowercase with true descenders that can be used by any Basic program, and can print in a combination of colors on varied backgrounds in 15 different sizes. It also lets the programmer (via a supplied program called ADDCHR), change or add to the default character set, creating customized alternative sets. Another feature is its ability to control cursor definition, scroll speed, Break key disabling, and non-destructive merges for animation.

I was anxious to try out some of these features so I opened the manual to the first section (a tutorial), and began to work my way through. The software accomplishes all it claims.

To demonstrate the default character set, a short Basic program was supplied. I entered: RUN "PRACTICE", and text in various colors appeared on a white screen. Just to prove that the graphics and text were really mixed, it drew circles around some of the letters in yet another color. The default character set was attractive and I found that it could really print up to 15 different sizes (using the different size options with a PRINT @ command takes practice!), and as many colors as the PMODE (I used PMODE4) would allow. Although I didn't try it, the manual explains how to produce pseudo colors also.

Once I mastered the use of the default character set I was ready to create some of my own characters. I have written some Spanish tutorials, and it has always been frustrating not to have the text capability necessary for such efforts. It is difficult to explain accents when you can only see uppercase text on the screen. I decided to put ColorText to the test and create lowercase, accented characters.

By following the tutorial and ADDCHR documentation, I created six special characters in only 30 minutes. I anxiously wrote a short Basic program to print some sentences in Spanish using my newly created characters. I ran the program and it worked the first time! It produced very crisp upper- and lowercase

letters, complete with accented vowels. The best part was that, even as a new user, it had taken me less than an hour. Each of the other enhancements were as satisfying; the programs were easy to use, very straightforward, and well documented.

ColorText uses the graphics mode to recreate what is on the text screen, by intercepting all input to the text screen and then copying it to the graphics screen via its own character generator. After interception, the character is also placed in the text screen. While the text screen is still in memory, you are actually viewing the graphics version. This becomes apparent when you disable ColorText and the text screen reappears.

Since you are really using two screens at once, be careful using PCLS and CLS; if you are using ColorText and you use CLS, the text screen is cleared. Since you are looking at the graphics screen and not the text screen, the CLS command will be transparent. If you use PCLS, the text screen will not be modified, while the graphics screen will be cleared. The documentation suggests you use CLS: PCLSx to make sure the two pages stay synchronized. Some interesting effects can be created, however, by intermixing the two.

ColorText can be appended to a program for a CSAVE; the documentation contains detailed instructions for doing this. For a disk-based program, ColorText can be dynamically loaded during program execution.

One suggestion I have is for a character size modification. If larger sizes can be created, why not smaller sizes? This feature would give the software added versatility available in other software packages. My only other comment concerns the price: at almost $80, this software is beyond the price range of many similar utilities. For the software developer who uses a heavy mix of graphics and text, ColorText would pay for itself quickly in saved programming time. For the casual user, however, the cost:benefit ratio would depend heavily on the individual interest of the programmer.

— by Norman Garrett

Sybex

2344 Sixth St.
Berkeley, CA 94710
(415) 848-8233 **$11.95**

A *FIRST-TIME* computer user is usually overawed by the presence of the computer, afraid that the least mistake will destroy it. After using the computer for a period of time this fear dissipates, to be replaced by a general disregard for the machine's safety. The manuals included with the computer, in an attempt to help the first-time user overcome his fear, de-emphasize the delicacy of the equipment. In fact, the manuals give the impression the computer can't be harmed.

Unfortunately, this isn't true. All kinds of problems are caused by owners who simply don't know that there are many "Do not do..." rules that they should follow. It is a failure of the manuals in not informing the owners of these rules.

Many disk system owners have never been told that smoking around a disk drive eventually causes problems with the drive and the data stored on the disks. Neither have they been told that a telephone bell is more than powerful enough to erase the data on a disk or a tape (several times I've caught myself about to place the phone beside a disk box on a table). Nor do they know that power fluctuations can cause irrepairable harm to the computer. And more than once I've seen someone put a soda can on top of their Color Computer.

For everyone who has worried about what is, and isn't, the safe thing to do around their computer, Rodnay Zaks has introduced this authoritative volume on computer DON'TS. This 218 page, easy-reading text is liberally sprinkled with tips on the care and maintenance of a computer system.

The book begins with a chapter that asks "Why bother?" The next chapter describes the main components of a computer system, and the rest of the book plunges directly into the subject of how to destroy your computer through carelessness, negligence, and sheer stupidity. The book is divided into 13 chapters covering floppy disks, hard disks, the computer, the CRT terminal (for the Color Computer this translates into the TV), the printer, tape units, the computer room, software, documentation, security, and maintenance.

What really makes the book effective are the numerous horror stores of misuse, abuse, and accident, and their consequences for the computer's owners. In almost all cases, the people involved spent considerable amounts of money correcting a problem that could have been prevented for only a few cents (and the use of common sense). One story details how an expensive computer system was destroyed by a visitor placing, and then spilling, a soft drink on the computer. The fluid went inside the computer, and promptly shorted out the CPU.

Sadly, the book isn't perfect. Many terms are not defined, and those that are, are too terse. Also, the instructions in the floppy disks chapter on how to insert disks in disk drives are incorrect (but the Tandy manual tells you how to do that).

Another point missed by the book was power failure. Mr. Zaks concludes that if a power failure lasts more than just a few minutes, a battery backup system capable of driving the computer system isn't worth the money. He mentions that the main purpose of a battery backup system is to give the operator time to properly powerdown the program and computer to prevent lost data and damaged hardware.

Other than these few nit-picking complaints, I found the book very informative. For a first-time user, the book will probably pay for itself in the prevention of a major problem with their system.

—T.K. *Color* staff

The Fixer

Tom Mix Software
3424 College N.E.
Grand Rapids, MI 49505 **$18.95**

HOW OFTEN HAVE YOU tried to put your favorite machine language program on disk? About 50 percent of your programs will not work with disks; then you have to pull out your controller and go back to using your cassette. After doing this a couple of times your favorite programs collect a lot of dust. The Fixer can solve that problem.

The Fixer is a short, 26 line utility that automatically loads your program from cassette then moves it into higher memory and saves it to disk. All you have to do is find the start and the end of your program. Instructions tell you how; then you run the program and give the name, start and end. That is all, the program does the rest.

Now I can run 3-D Brickaway, Madness and the Minotaur, Pyramid, and Bedlam on disk without a problem. Fixer is intended to make running your own programs convenient to your disk system. Don't abuse it by using it to make unauthorized copies.

It does not work with all of the programs. The only one I had trouble with was Raaka-Tu, which would load, but would not run correctly.

— by Jeff White

NEW:PRODUCT$

Klendathu

Radio Shack
One Tandy Center
Fort Worth, TX 76102

Klendathu (R.S. #26-2567) is a space adventure based on the book *Starship Troopers* by Robert A. Heinlein. Up to two players are transported to a Terran Federation starship where they serve as Mobile Infantry (M.I.) forces fighting The Bug Wars on the planet Klendathu. Each player has three timed drops to the planet's surface where he must destroy as many bugs as possible using limited fire power, then return to the ship before his special suit depletes its protective energy. Points accumulated for destroying the three types of bugs and completing each mission earn the player promotions in rank as well as pay. Klendathu offers exceptional graphics and optional keyboard or joystick control during play. The game requires a 16K cassette system.

Circle No. 70 on Reader Service Card

Canyon Climber

Radio Shack
One Tandy Center
Fort Worth, TX 76102

Canyon Climber (R.S. #26-3089) challenges the player to accumulate points by maneuvering a climber through three levels of play during which he must set dynamite charges and avoid a number of hazards including mountain goats, indian arrows and falling rocks. The climber is controlled from the keyboard or by using optional joysticks to maneuver him through the three high-resolution graphics playing levels. The player receives a bonus climber upon completing all three levels successfully, and is returned to the first level to begin again at a faster pace. The Canyon Climber ROMpak requires 16K RAM.

Circle No. 71 on Reader Service Card

Color Space War

Spectral Associates
141 Harvard Avenue
Tacoma, WA 98466

Color Space War puts you in command of the last remaining Viper in defense of your side. You must break through enemy fighters and the defenses of the Death Star to win. The Death Star can fire defensive missiles, but you can outsmart the Star by hitting its one weak spot. Watch out for the black hole — the closer you get to it, the stronger its gravity pull becomes. As you maneuver to shoot the Death Star, you must be on guard for the four invisible Space Mines, which become visible if you get too close; they explode about one second later. Special features include a cloaking device you can use to protect your Viper, sonic alert to help warn you of Space Mines, and 16 skill levels. Space War is written in machine language for fast-action, and uses the highest resolution graphics available. It requires 16K RAM and joysticks, but does not require Extended Basic. Price is $21.95.

Circle No. 72 on Reader Service Card

Genealogical Programs

TWM
P.O. Box 232
Lititz, PA 17543

The first genealogical programs for the Radio Shack Color Computer make it possible to get started in genealogical computing easily and cheaply. The twin programs FAMILY and FAMPRINT require 32K Extended Basic and a line printer. Both programs are $9.95; they will maintain eight generations and 255 ancestors. They will print out a five generation pedigree chart, family group charts and a reference number index.

Circle No. 73 on Reader Service Card

Galax Attax

Spectral Associates
141 Harvard Avenue
Tacoma, WA 98466

Galax Attax has fast, challenging action where rows of alien attackers leave flying formation and swoop down on your ship dropping bombs all the while. You must defend by destroying rack after rack of varying alien attackers and avoid being hit by their bombs. Special features include bonus ships after you destroy the sixth rack of attackers, and continuous game after game play just by pressing the fire button. Galax Attax gets progressively more difficult as you destroy the waves of attacking alien ships. Galax Attax requires 16K RAM and joysticks but not Extended Basic. The price is $21.95 on cassette.

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Saturn Electronics Printer

Saturn Electronics
Company, Inc.
57-61 Cloverdale Blvd.
Bayside, NY 11364
(212)423-4626

The Saturn Electronics Printer/Modem Switcher does not require batteries or any power; does not require extra cables and adapters; comes assembled and tested; has the highest quality workmanship. You may select between modem or printer at the flick of a switch. The printer automatically checks the RS-232 port and gives visual indication. It adds three extra RS-232 ports to your computer. Units may be daisy-chained together to give you more ports. The machine is easy to use and to hook up, and does not require any wiring, soldering or any technical knowledge. This product includes a two year warranty on parts and labor. Introductory price: $29.95.

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Glaxxons

Mark Data Products
24001 Alicia Parkway
Suite 207
Mission Viejo, CA 92691
(714)768-1551

Glaxxons is a super hi-res space game that pits your playing skills against squadrons of swooping, diving enemy spacecraft. Your goal is to eliminate as many aliens as possible while avoiding your own destruction. Seven selectable skill levels coupled with automatic game acceleration provide a challenge for novice and expert players. This machine language program is available on 16K cassette for $24.95 and 32K disk for $29.95.

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Color Disk Kit

American Small Business
Computers, Inc.
(918)825-4844

Features of the Color Disk Kit include: 156,672 characters of user storage per disk; it plugs into the computer's program pak port; it is capable of adding up to four drives for a total of over 626,000 characters of storage.
The drive kit is fully compatible with Radio Shack hardware and software. The kit includes one 5 1/4 inch double density, 40 track floppy disk, cable, plug-in program cartridge, one blank 5 1/4 inch disk, reference manual and operator instructions. The cable allows up to two drives on a system — an optional cable allows up to four drives. The kit requires Extended Color Basic. The price is $399.

Circle No. 77 on Reader Service Card

Color Computer Comics

Radio Shack
One Tandy Center
Fort Worth, TX 76102

Superman and Wonder Woman join up with the Metropolis Computer Master,

Please turn to page 94

Forum Sixty-Eight

Color Computer News

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NEW:PRODUCT$

Continued from page 92

smart Alec and Shanna, who use their Color Computers to provide the super heros with information to save the Metropolis World's Fair. Why might the Metropolis World's Fair be in danger? Why, because Lex Luthor, scientific genius and arch-criminal, was denied an exhibit in the Computer and Electronics Technology Exhibit, and has threatened to blow up the fair in retaliation unless he receives $1 billion in ransom money. Woven around this basic adventure story is a lot of information about the history of computers in general, and TRS-80 micros in particular. The comic book is available free from Radio Shack.

Circle No. 78 on Reader Service Card

Compact Disk System

Amdek
2201 Lively Blvd.
Elk Grove Village, IL 60007

Amdek's original disk drive system was not intended to run on the Color Computer, but with the Color Computer's tremendous growth in popularity, the system has been modified to work with Radio Shack equipment. The system's main features are: it's economical price; compact micro-floppy disk drive that accomodates two cartridges for up to 1 megabyte capacity; recording format, data transfer rate and disk rotation speed are compatible with standard 5 1/4 inch floppy disk drives; hard plastic 3 inch micro-floppy disk cartridges have a protective, hinged cover and a write protect mechanism. The Amdek disk is double-sided and has a different-colored light indicator so you will know whether you are using side A or B. The disk is shirt-pocket size and the plastic cartridge is a nice protection. The disk system can be set to be either drive 0 and 1, or drive 1 and 2.

Circle No. 79 on Reader Service Card

FOR...NEXT (08,83)

August brings the end of summer, but with it comes the start of a new column for **The Color Computer Magazine**. Dr. Paul Kimmelman will begin his regular feature, GOTO SCHOOL, wherein he will look at education and microcomputers from a computer-literate school administrator's point of view. On the same lines, David Stevens, an elementary school teacher, has some games he uses in his classes that make learning fun.

Other treats will include a game or two, a software author's look at the Color Computer, some construction projects, and a lot more, including a nifty surprise from Dennis Kitsz.

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END OF FILE

Computer magazines seem to deal more and more with software than anything else. Even hardware articles include information, if not actual program listings, about how to write software to exercise, test, and use the project. This is so because software is what the user *really* uses; the computer is just a medium, the context of operation for your software. Without the computer software has no world to live in; but once that digital world exists for it, life begins, and evolves.

With software life comes many dangers, as well as opportunities. Dangers include the forever elusive program flaw, or "bug." And just about all software (yes, A-L-L, *all*) harbors bugs. Those who claim to have bug-free software can only claim that no bugs have been found since they fixed the last one some weeks or months ago. This allows the bug-free quality index to follow some combination of the frequency of errors corrected and the age of the last patch.

This means that if you are interested in software, you will eventually become involved in debugging some program or another. *Especially* if you are "only" a user of software. Users are the ones software is written for, and one who uses software will come up with new uses for it, or new data to use it on, or new ways of operating it — none of which the original author thought of or planned for. Users who don't think of new things will eventually create a new condition that uncovers some long-hidden esoteric bug.

So, a magazine about computers is a magazine about software is a magazine that needs debugging. That's where I come in. I'm here to ferret the bugs out of articles and their programs (or is it programs and their articles?), *before* they get printed. Since I've been here a full month and this is our fifth issue, it looks like I'm off to a flying start (who says techies can't be facetious?). So let the corrections roll.

In our March issue, "Stash a Directory" would only save five of the 10 directory sectors. Since the gran we stole is only 9 sectors long, this correction does the best it can by saving and restoring only the first nine sectors, leaving the seldom-used tenth sector unsaved. The Basic DBM, as basic as it was intended (no error trapping), harbored the elusive indexing bug (insert Q=Q-1 in line 9290), as well as the overused variable bug (change variable M in lines 6560 through 6580 to variable S). We still suggest you get help to tailor this program to any important management problems.

In the Custom Color column on memory expansion, it should be noted that systems expanded to 64K will appear to be 32K on power up. Extra software is required to swap the extra 32K page into the memory map when it's needed.

In April's issue, the "Reformat Your Video" listing was from a FLEX assembler, and will not work on most non-FLEX assemblers without extensive translation. We'd like to re-publish it, but barring the space problem, we decided to offer a free full-size copy of the original corrected listing to those who send us a request with a self addressed, stamped, 9 by 12 inch envelope. In Custom Color, Figure 4b, the line from A1 should connect directly, not through the inverter buffer. Richard Ramella sent us a letter with corrections for "The Sorcerer's Puzzles" that appeared in last month's INKEY$ column. They have been reprinted here for those who missed our June issue. However, you should also add line 130 QQ=100 to "Firecracker."

In the May issue, "Condense Your Programs," Table 1, is missing parentheses for the PEEK(n) statements. "Color Animation," Listing 1, was missing a graphic command in the string of Line 150: ...R8;F4;G4;... should be ...R8;F4;D4;G4;... and Line 160 should start A1$="... Also, on page 30, the right hand column near the bottom should be: B$+A5$+L1$, not B$=A5$=L1$. "Space Trek" had a unique problem, and its correction is listed in the Table of Contents of this issue. Custom Color, Listing 1, Line 10, should be: POKE &HFF55,0.

These are all known bugs for the first three issues. Feel free to call or write with any others you may discover, and any fixes you may have found for them. *— J.T., Technical Editor*

March

Stash a Directory

DIRSAV

```
DEL 130-240
130 FOR S = 2 TO 10
140 DSKI$ 0, 17, S, A$, B$
150 DSKO$ 0, 34, S+8, A$, B$
160 NEXT S : END
```

DIRGET

```
DEL 340-
300 CLEAR 600 : FOR S = 10 TO 18
310 DSKI$ 0, 34, S, A$, B$
320 DSKO$ 0, 17, S-8, A$, B$
330 NEXT S : END
```

April

The Sorcerer's Puzzles

Firecracker

```
130 QQ=100
460 V$ =MID$ (A$(B), C, 1) : IF
V$ =" " THEN530 ELSE S =VAL(V$)
: A$(B) =LEFT$ (A$(B), C -1)+" "
 +RIGHT$ (A$(B), LEN(A$(B)) -C)
```

Color Stones

```
300 D$ =LEFT$ (D$, 3) +G$ +RIGHT
$ (D$, LEN (D$) -4)
360 D$ =LEFT$ (D$, A -1) +F$ +RI
GHT$ (D$, 27 -A)
390 D$ =LEFT$ (D$, A -1) +G$ +RI
GHT$ (D$, LEN (D$) -A)
490 N$ =MID$ (C$, A -3, 3)
492 IF N$ =A$ THEN C$ =LEFT$ (C$
, A -4) +B$ +RIGHT$ (C$, 28 -A)
ELSE C$ =LEFT$ (C$, A -4) +A$ +R
IGHT$ (C$, 28 -A)
493 N$ =MID$ (C$, A +1, 3)
500 IF N$ =A$ THEN C$ =LEFT$ (C$
, A) +B$ +RIGHT$ (C$, 24 -A) ELS
E C$ =LEFT$ (C$, A) +A$ +RIGHT$
(C$, 24 -A)
```

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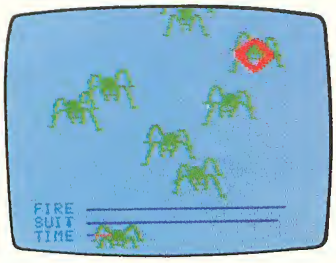

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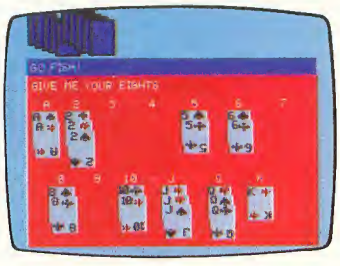

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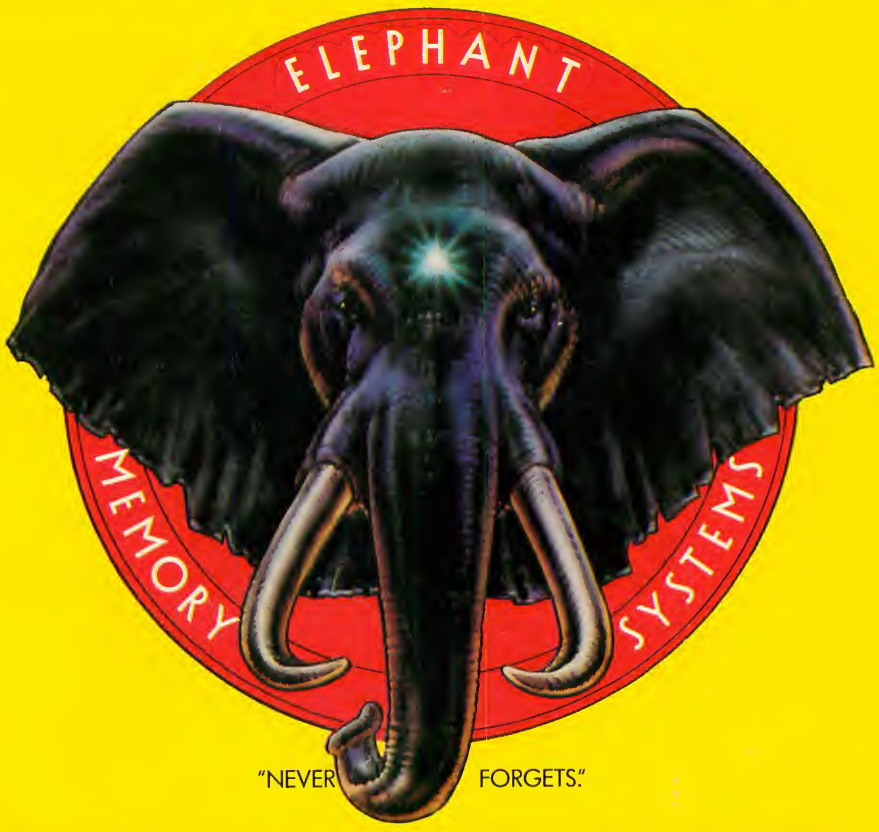

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